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No.

IN THE

Supreme Court of the United States

OCTOBER TERM, 1984

ENVIROTECH CORPORATION
and
ENERGY FUELS NUCLEAR, INC.,

Petitioners,

v.

AMSTAR CORPORATION,

Respondent.

APPENDIX TO PETITION FOR WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

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UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

AMSTAR CORPORATION,
Plaintiff/Appellant,
v.
ENVIROTECH CORPORATION, AND
ENERGY FUELS NUCLEAR, INC.,
Defendants/Appellees.

No. 83-1090

DECIDED: March 27, 1984

Before MARKEY, *Chief Judge*, and FRIEDMAN and DAVIS, *Circuit Judges*. MARKEY, *Chief Judge*.

Appeal from that part of a judgment of the United States District Court for the District of Utah finding non-infringement of U.S. Patent No. 3,523,889 ('889 patent). We *reverse* and *remand*.

Background

In January 1979, Amstar Corporation (Amstar) sued Envirotech Corporation (Envirotech) and Energy Fuels Nuclear, Inc. (EFN), charging infringement of process and apparatus claims 1 through 10 of the '889 patent, active inducement of others to infringe, and contributory infringement. Envirotech and EFN asserted defenses of non-infringement, invalidity under 35 U.S.C. § 103, and unenforceability for failure to disclose certain prior art to the Patent and Trademark Office (PTO), and counter-claimed for a declaratory judgment of invalidity, non-infringement and unenforceability.

The action was tried to the court from June 22 through June 30, 1981. The trial transcript ran over 1,150 pages. Some 300 exhibits totaled over 4,000 pages of technical diagrams, photos, and articles. In-court and videotaped experiments were demonstrated, and the court conducted an on-site inspection of a

laboratory version of Envirotech equipment. After submission of counsels' supplemental memoranda, the court issued a Memorandum Decision and judgment on May 3, 1983.

Validity

In its 66-page Memorandum Decision, the district court devoted 59 pages to a thorough discussion of the facts and law governing the validity issue. Though the court confessed to a felt inadequacy respecting the involved technology, much of its discussion thereof was flawless. Finding that the inventions claimed in the '889 patent (Eis inventions) clearly survived certain non-statutory (and thus erroneous) tests, the court held the patent valid and enforceable.[1]

The subject matter of the inventions in suit and the real-world milieu surrounding their nature, their birth and growth, and the reaction of experts to these inventions, and the reactions of the industry and of Envirotech, were set forth in the court's Memorandum Decision.

The court generally described the subject matter of the '889 patent:

> [A] process and apparatus designed to enable industrial enterprises to separate solids from a large volume of liquid over a relatively short period of time. Far from letting muddy waters settle in their own good time, [the '889 patent discloses] a continuous flow process that takes advantage of the efficacy of chemical flocculating agents in separating solids — especially finely-divided solids — out of a liquid suspension or emulsion, enhanced further by the

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[1] As indicated in Environmental Designs, Ltd. v. Union Oil Co., 713 F.2d 693, 699, n. 9, 218 USPQ 865, 871, n. 9 (Fed. Cir. 1983), and in Jones v. Hardy, No. 83-900, slip op. at 9, n. 3, 220 USPQ at 1025 (Fed. Cir., February 8, 1984), the court need only have held that Envirotech failed to carry its burden of proving invalidity. 35 U.S.C. § 282. A determination that a patent challenger has failed to carry the § 282 burden equates with the reality that the result of a patent trial, like that of any other, binds only the parties and those in privity with them.

design of the apparatus and by the specific steps taken in the process.

Citing 29 internal memoranda in evidence as illustrating the skepticism of Envirotech's engineers ("re-written the laws of gravity"; "a new concept *** verdict *** undecided"), and the "great effort" of Envirotech's engineers, technicians, and specialists to gather and analyze data in an attempt "to discern the mechanism by which the Enviro-clear[2] clarifier/thickener operates," the district court stated:

> Having expended such great efforts to discover if and how the Enviro-Clear method works, it is ironic at least to some extent for Envirotech to now assert that the Eis process was obvious to those skilled in the art. Perhaps, like a brilliant move in a game of chess, it seems so obvious and simple — after you have once seen it played.[3]

The district court: carefully made the findings required by Graham v. John Deere Co., 383 U.S. 1, 148 USPQ 459 (1966); avoided the hindsight approach on which it said Envirotech depended; rejected the improper each-element-is-old approach; found that the Eis inventions passed the erroneously "required" tests of "synergism" or "unexpected results"; found that the Eis inventions filled a long felt need unmet by others who tried and failed, caused abandonment of long standing traditional testing methods for this type of equipment, achieved commercial success and trade acceptance, and ran *contrary* to the teachings of the prior art as synthesized in Envirotech's Manual just before Eis made his inventions; found that Eis proceeded "afoul of the rule" taught by the prior art against introduction of feed into the

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[2] "Enviro-clear" is a registered trademark of Amstar, Registration No. 1,093,696, dated June 20, 1978, for its commercial embodiments of the inventions claimed in the '889 patent.

[3] An abuse of the judicial process resides as much in the presentation of a knowingly frivolous defense as in the filing of a knowingly frivolous complaint or appeal. No cross appeal was filed and validity is not challenged on appeal. Apparently, Amstar presented to the district court no claim for attorney fees and costs specifically relating to this "ironic" defense.

settling zone; found (without designating) that some of the non-PTO considered prior art was cumulative and some was not; and reached the conclusion that the Eis inventions would not have been obvious "based upon a preponderance of all the evidence as independently weighed and considered by this court."[4]

The Claims

Though claims 1-10 were asserted, the appeal can be determined on consideration of independent claims 1, 8, and 9:

> 1. A continuous process for rapidly separating finely divided suspended solid materials from liquids at a predetermined controlled rate, comprising the steps of forming a slurry of solid agglomerates in an influent feed of liquid containing finely divided and suspended solids by the addition of a settling aid, forming a settling zone having relatively stationary upper boundary and containing previously formed solid agglomerates, introducing said influent liquid slurry at a central position within said settling zone and centrally of said previously formed solid agglomerates, arresting the motion of the influent feed and displacing the same outwardly through said previously formed agglomerates to cause additional agglomeration of the solids and the formation without additional agitation of a dense settleable

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[4] The district court: unnecessarily undertook the extra effort involved in independently re-determining validity ab initio, rather than determining on all the evidence whether Envirotech had carried its burden of proving invalidity as the statute requires, 35 U.S.C. § 282; spoke of "synergism" and "unexpected results" as requirements rather than evidence, see Kansas Jack, Inc. v. Khun, 719 F.2d 1144, 1150, 219 USPQ 857, 860 (Fed. Cir. 1983); quoted indications that "combination patents" are somehow different and require special scrutiny, see Medtronic, Inc. v. Cardiac Pacemakers, Inc., 721 F.2d 1563, 220 USPQ 97, 99-100 (Fed. Cir. 1983); stated that the presumption of validity is "weakened" when non-considered pertinent art is introduced; discussed the obviousness of the "patent" rather than of the claimed inventions; and used the present tense "is obvious" rather than the statutorily required "would have been obvious". see Rosemount, Inc. v. Beckman Instruments, Inc., No. 83-974/83-1238/83-1251 slip op. at 7 n.3 (Fed. Cir., February 16, 1984). Those errors, however, tilted in favor of Envirotech and do not in this case affect the district court's holding of validity.

mass of the solids and agglomerates, continuously removing a dense underflow from beneath said settling zone at a rate to maintain said relatively stationary upper boundary, and continuously removing an overflow of clarified liquid from above said upper boundary of said settling zone, whereby separation of the solids and liquids rapidly occurs in said settling zone.

8. A continuous process for treating liquids to remove substances therefrom in the form of solid particles and agglomerated solid particles, which comprises forming and maintaining a settling zone of concentrated slurry containing suspended solid particles and agglomerated solid particles of like nature to those to be formed and sep [sic] separated, mixing solids-containing liquid to be processed with a settling and agglomerating agent, said mixing producing a liquid slurry containing freshly agglomerating solids, introducing said liquid slurry as an influent feed at a central position within said settling zone, arresting the motion of said influent feed and displacing the same outwardly through the concentrated slurry in said settling zone to effect additional agglomerations of the solid particles, whereby relatively large agglomerates of solid particles are formed which settle rapidly without additional agitation to form a dense underflow of agglomerates and entrained solid particles, the point of arresting said influent feed being close to said central point of introduction of the influent feed, controlling the depth of said settling zone by withdrawal of said defense underflow so that said settling zone of concentrated slurry is provided with a relatively stationary upper boundary, the rate of withdrawal of said dense underflow being such that said upper boundary of the settling zone is above the point of arresting the motion of the influent feed, and withdrawing clarified liquid from above said settling zone of concentrated slurry.

9. In an apparatus for rapidly and continuously separating finely divided and suspended solid materials from liquids at a predetermined and controlled rate, a settling vessel having top on bottom outlet means, inlet means including conduit

means extending to a centralized position within said settling vessel, means for introducing a substantially [sic] vertical flow of influent feed of liquid containing freshly agglomerating solid materials to said centralized point of entry established by said conduit means, unitary substantially horizontal baffle means adjacent the point of entry established by said conduit means for arresting and altering the direction of motion of said influent feed whereby the influent feed is directed in a horizontally outward direction with respect to said centralized point of entry, means controlling the rate of discharge of solid materials through said bottom outlet means to control and thereby establish settling and sludge zones above and below said centralized point of entry of influent feed, and means for withdrawing a clarified effluent through said top outlet.

Infringement

As shown by unchallenged evidence, the accused product performs each of the process steps set forth in claims 1 and 8 and contains each of the elements set forth in claim 9. The district court's attention, however, became focused on a mechanical mixer inserted in the feedwell of the accused product, and on the process step performed by it, namely mechanical pre-mixing of the slurry. Led to the erroneous belief that Amstar had argued for patentability on the basis that Eis avoided all mechanical mixing anywhere in the system, under the apparent impression that infringement is avoided when an element of an accused device is not found in the claims, and failing to note the presence in claim 8 of the step of pre-mixing in the slurry, the district court stated:

> The combinative nature of Amstar's patent rights effectively limits the scope of enforceable claims under the Eis patent. If Envirotech's combination of elements differs in a material way from that described by Eis, there is no infringement.

A crucial area of difference between the Amstar and Envirotech equipment is the use of sophisticated mechanical

mixing to promote flocculation. The Envirotech device is constructed around the multichamber impeller mixing system; Amstar's Enviroclear equipment uses no mixing blades, relying instead upon inflow injection of flocculant solution into the feed launder or feed pipe using specially designed nozzles.

Following initial rejection of the Eis application the inventor emphatically argued that one reason why the Enviroclear process was novel, non-obvious and patentable was its use of other than mechanical means:

> One point particularly stressed during the interview was the fact that applicant's claimed process and apparatus effects a separation of finely divided and suspended solids from an influent feed at an unusually rapid rate, *without relying upon* either the accretion *or growth of agglomerates through forced agitation* or the use of a free settling zone.

* * * * * *

While counsel for Eis was not specifically referring to the mixing apparatus now described in the Emmett Patent and used in the Hi-Capacity Thickeners, it seems plain that Envirotech relies upon mechanical stirring to achieve good flocculation while the Eis/Amstar equipment does not.

* * * * * *

Disclaimer of mechanical mixing to achieve good flocculation, made in the course of the prosecution of the Eis patent, would exclude mechanical mixing as an "equivalent" as a consequence of this doctrine of "file wrapper estoppel."

* * * * * *

The Eis patent as issued makes no claim which by its terms encompasses mechanical mixing to achieve optimum flocculation. To even accept the argument that the Emmett apparatus is an equivalent, one would have to wholly disregard the positive effects of the mechanical mixing system. This cannot reasonably be done in light of all of the evidence.

* * * * * *

The Court finds as a matter of fact that the Emmett/Envirotech invention is not the Eis/Amstar invention and concludes as a matter of law that the former does not infringe upon the plaintiff's valid rights in the latter within the meaning of 35 U.S.C. § 271. Amstar retains enforceable legal rights in its specific process, but not in the general result. It must be remembered that combination patents are to be carefully scrutinized [citations omitted].

* * * * * *

Even assuming that some initial diagrams and models of the Envirotech equipment followed too closely the outline first propounded by Eis, the paths of the parties have long since diverged and initial resemblance, now avoided, has done the plaintiff no cognizable injury or wrong. Plaintiff's complaint should be dismissed. Defendants' claims of patent invalidity should be dismissed.

* * * * * *

Issue

Whether the district court erred in reaching its determination of non-infringement.

Opinion

Though literal infringement of a properly interpreted claim is a fact question, its determination may be rendered clearly erroneous through an improper interpretation and application of the governing law. In that event, as here, the determination must be overturned as having resulted from error as a matter of law.

The law of infringement requires that the asserted claims be compared with the products or processes accused of infringement. Graver Tank & Mfg. Co. v. Linde Air Products Co., 339 U.S. 605, 85 USPQ 328 (1950); Rel-Reeves, Inc. v. United States, 534 F.2d 274 (Ct. Cl. 1976); Astra-Sjuco, A.B. v. U.S. International Trade Commission, 629 F.2d 682, 207 USPQ 1

(CCPA 1980). That was not done here. On the contrary, in the seven pages of the Memorandum Decision devoted to the infringement issue, it is made clear that the district court was led to take a wrong turn in determining the infringement issue.

Infringement is not determined by comparison between parts of the description in a patent and the accused process or product, or by comparison between commercial products sold by the parties. Accused products made, sold, or used, and accused processes performed, before suit must be compared with the claims. That products may have been modified after suit is brought, and may or may not be accused of infringement, does not remove the need for that comparison.

Modification by mere *addition* of elements or functions, whenever made, cannot negate infringement without disregard of the long-established, hornbook law expressed in Cochrane v. Deener, 94 U.S. 780, 786 (1876); Eastern Rotorcraft Corp. v. United States, 397 F.2d 978, 981, 154 USPQ 43, 45 (Ct. Cl. 1968) (infringement not avoided by adding an additional element); McCullough Tool Co. v. Well Surveys, Inc., 343 F.2d 381, 402, 145 USPQ 6, 22 (10th Cir. 1965), cert. denied 383 U.S. 933, 148 USPQ 772 (1966) ("But infringement cannot be avoided by the mere fact that the accused device is more or less efficient or performs additional functions."); Acme Highway Products Corp. v. D.S. Brown Co., 473 F.2d 849, 855, 177 USPQ 130, 135 (6th Cir.), cert. denied 414 U.S. 824, 179 USPQ 321 (1973) ("An accused device cannot escape infringement by merely adding features, if it otherwise has adopted the basic features of the patent."). Further, the law recognizes the irrelevance of apparatus distinctions in determining infringement of process claims. International Glass Co. v. United States, 408 F.2d 395, 400, 161 USPQ 116 (Ct. Cl. 1969).

Thus an accused product could not be found non-infringing because it lacked a flared outlet feed pipe, that element being irrelevant because it is present only in *non-asserted* claim 11.

Nor could substitution of a rotating disc for the baffle of claim 9 escape infringement, the two being equivalent and the substitution bearing no relation to claims 1 and 8. Nor could absence from the claims of a limitation to mechanical mixing *before* introduction of the slurry into the settling zone be thought controlling, when claim 8 specifically mentions pre-mixing (whether or not mechanical) and pre-mixing bears no relation whatever to claims 1 and 9. Similarly, the presence of additional ("lamella") plates in some Envirotech drawings cannot negate infringement, lamella plates being irrelevant because they are not included in the accused products as sold, because they have no effect on the processes of claims 1 and 8, and because they are not an element of product claim 9.

Often, as here, consideration of the infringement issue may be benefitted by recognition of the findings made in considering the validity issue (Envirotech tried various schemes to "neutralize Enviro-clear's influence" and "counteract the Enviro-clear threat"; Envirotech's apparatus and process "[bear] a striking resemblance to the preferred embodiment of the Amstar apparatus and process described in the Eis patent".[5]

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[5] Amstar's brief refers to Envirotech's "willful and deliberate infringement." Envirotech's brief makes no claim that counsel was consulted before it elected to produce and sell the accused products. The district court's findings would appear to support the "willful and deliberate" characterization. Nonetheless, no finding of willful infringement was made, and the question is therefore not before us. Presumably, the district court will consider on remand Amstar's requests for such findings and for costs, treble damages, and attorney fees.

Similarly, though Amstar points to Envirotech's corporate policy of disregarding the patent rights of others, as reflected in its being held in contempt of court four times in a patent case, Peterson Filters & Engineering Co. v. Emico Corp., 155 USPQ 89 (D. Utah 1967), aff'd, 406 F.2d 431 (10th Cir. 1968), cert. denied 395 U.S. 963 (1969); 166 USPQ 425 (D. Utah 1970); 174 USPQ 185 (D. Utah 1972); 178 USPQ 337 (D. Utah 1973), that policy is not before us. Envirotech's approach to the patent system and its disregard of plaintiff's patent rights and court orders in Peterson Filters is of general interest, however, in light of its having sought and

Important to determination of the infringement issue, also, are the findings establishing the *pioneer* nature of the Eis inventions (Eis abandoned the traditional design of thickening equipment; results obtained were "surprising", "striking", "unexpected" and "synergistic"; Eis' process is "far more effective" than conventional equipment; "Nothing * * * indicated the kind of results one could obtain if the Eis process was used"; the entire industry testing procedure was modified or abandoned "wholly dependent upon the teachings of the Eis patent").

The statute provides no support for the district court's statement that "the combinative nature of Amstar's patent rights effectively limits the scope of enforceable claims under the Eis patent." There is no separate classification of "combination patents" and no basis for considering claims to combinations of elements differently from any other. Richdel, Inc. v. Sunspool Corp., 714 F.2d 1573, 1579, 219 USPQ 8, 12 (Fed. Cir. 1983); Medtronic, Inc. v. Cardiac Pacemakers, 721 F.2d 1563, 220 USPQ 97, 100 (Fed. Cir. 1983).

As discussed infra, a statement made during prosecution of the application for the '889 patent which related to avoidance of mixing *in the settling zone*, cannot be applied as a form of estoppel precluding application of the claims to Envirotech's apparatus which *also* avoided mixing in the settling zone.

The district court's Memorandum Decision overlooked the claim charts (Px 32) introduced and analyzed at trial and presented here as a part of Amstar's brief on appeal. Those charts establish unequivocally that the accused apparatus employed at Envirotech's pilot plants, and as originally sold to Eagle Coal and Dock and to EFN, constituted literal infringements of claims 1, 8, and 9.

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obtained a patent on one of its modified versions (Emmet). Though that happened seven years after the '889 patent issued, Envirotech did not cite the Eis inventions to the PTO, a lapse on which the district court commented: "Ironically, the Emmet patent does not list the Eis patent as a relevant prior art example."

The record further illustrates that the modifications assertedly made by Envirotech, whenever they may have been made, are either irrelevant or fail to escape infringement. The accused products, including those modified, are the same, they perform the same function in the same way, and they achieve, as the district court found, the same result as the claimed inventions. See Sanitary Refrigerator Co. v. Winters, 280 U.S. 30, 41-42, 3 USPQ 40, 44 (1929).

In this case, the merely colorable variations so vigorously pressed by Envirotech are of a kind with those described by the Supreme Court as fostering "the piracy" and consequent defeat of the disclosure purpose of the patent system. Graver Tank, supra, 339 U.S. at 607, 85 USPQ at 330. Infringement is clear on this record.[6]

Envirotech's Brief[7]

The brief filed by Envirotech on this appeal, presented to assist this court in determining that the finding of non-infringement was not clearly erroneous, contains *not one* reference to any step of process claims 1 and 8, or to any element of product claim 9, that is even asserted to be absent from the accused processes and products of Envirotech.

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[6] The district court's treatment of differences in the Amstar and Envirotech *commercial* products included a statement (repeated in Envirotech's brief here) that Amstar's approach to equivalence could lead to a conclusion that, except for a simple design difference, "a Phillips head screwdriver is a standard screwdriver". The district court's error of law, repetition of which is sought here by Envirotech, lies in the failure, as above indicated, to compare the *accused* products and processes with the *claimed* products and processes.

[7] Envirotech challenges none of the findings on which rests the district court's conclusion that the '889 patent is valid. Nor does Envirotech challenge the district court's finding that it produced the accused products because its thickener business was "in jeopardy" as a result of Amstar's presence in what Envirotech's engineers called its "sandbox".

Unable to point to any part of Eis' claimed inventions not appropriated by it, Envirotech says it avoided infringement solely because it *added* mechanical pre-mixing in the feedwell.[8] Unable to escape or distinguish any of the many authorities cited in Amstar's brief clearly explaining why that position is contrary to law, Envirotech simply ignores them all.

Envirotech's brief says the modifications discussed by the district court played no role in its non-infringement finding, and that the district court properly found non-infringement because it held that the claims of the '889 patent, in Envirotech's words, "did not encompass the mechanical mixing employed by Envirotech to achieve optimum flocculation". Envirotech's brief then describes it premixing impellers and baffles and says *"They* cannot therefore infringe any claim of the Eis patent" (emphasis added). Of course "they" cannot infringe, "they" are not charged as infringements, "they", as the authorities make plain, are simply and totally irrelevant, *see, e.g., Eastern Rotorcraft, supra*, 397 F.2d at 981, 154 USPQ at 45.

Envirotech's brief repeatedly states (without record citation) that the district court "compared the Envirotech apparatus with the Eis claims", and, at the same time, that "a claim-by-claim determination would have been superfluous once the court found a feature [Envirotech's mechanical pre-mixing] missing from all the claims". That view would stand the law of infringement on its head, and would fatally undermine the long-established legal principle that non-infringement is shown when an element or step in the claims is missing from the accused product or process, not vice-versa.

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[8] The equally irrelevant presence of lamella plates and absence of a flared feedwell outlet or a flat baffle plate are not mentioned in Envirotech's brief. At oral argument it was asserted, without support in the record, that some product of Envirotech discharged the slurry longitudinally rather that outwardly into the settling zone.

Envirotech then says that the district court interpreted the scope of the claims in suit as excluding Envirotech's mechanical pre-mixing in the feedwell, and that the claims cannot therefore be expanded to include a functional equivalent of that pre-mixing in the feedwell. The argument is, in all charity, disingenuous. The list of elements and steps "excluded" by the claims in suit, as by every patent claim, is infinite. Nor is there any need whatever to "expand" the claims to "include" a functional equivalent of Envirotech's pre-mixing in the feedwell. The existence and function of pre-mixing in the feedwell (though the district court was led astray respecting them) are simply of no moment whatever. It is not the law that each element of Envirotech's accused process and product, or an equivalent of each element, must be found in the claims. The *claims* are not accused of infringing anything. Envirotech is obviously free to use its pre-mixing chamber per se to its heart's content.[9]

Pre-mixing would be relevant only if it were listed as an element or step in a claim and if it were *absent* from Envirotech's apparatus and process. When, as here, Envirotech adds its pre-mixing chamber to apparatus that, in its structure and in the process it performs, literally infringes claims 1, 8, and 9, infringement is not by the addition avoided.

Envirotech says Amstar seeks to define a "gossamer" boundary for the claims, and attempts a "total eclipse of the technology where the district court found the penumbra of the claims strictly delineated". As sole support for that statement, Envirotech quotes the district court: "Amstar retains enforceable legal rights in its specific process, but not in the general result", and its statements that the claims "exclude" and do not

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[9] Or to refrain from its use. The uncontradicted testimony at trial was that Envirotech's customers simply *deactivated* or removed the mechanical mixers in the feedwell of Envirotech's products. Whether mixers in the feedwell were or were not used is, however, totally irrelevant.

"encompass" mechanical mixing in the feedwell. Nowhere does or can Envirotech indicate wherein it is not employing precisely the claimed "specific process," or wherein an unpatentable "general result" is at all relevant. Nor, as above indicated, does Envirotech support the district court's misinterpretation of the law of infringement reflected in its "exclude" and "does not encompass" statements.[10]

Envirotech's effort to create a prosecution history ("file wrapper") estoppel wastes the court's and opposing counsel's time, because the effort is devoted to "proving" what is unchallenged and irrelevant, i.e., that claims 1 and 9 "clearly" do not "include" mechanical mixing in the feedwell.[11]

Moreover, Envirotech argues (contrary to the record) that exclusion of such pre-mixing was the sole basis for allowance, and goes on to employ a distorted quotation from Eis' prosecution history, the distortion constituting a deletion of precisely the language which totally undermines its argument.

As presented to the court by Envirotech, the quote is:

> * * *[F]orced hydraulic or mechanical agitation to obtain growth or accretion of agglomerate particles * * * is entirely contrary to the concept of applicant's invention, and would defeat applicant's purpose through action of fluid forces in shear which would disrupt and break up the dense clumps of agglomerates which form as a result of applicant's processing.

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[10] Envirotech says its pre-mixing in the feedwell "promote[s] flocculation throughout the apparatus", but there is no evidence of record to support that statement. If there were, the assertion would nevertheless be irrelevant in view of the clear infringement of the claimed process and product claims.

[11] The effort could never establish an absence of "mixing" from claim 8.

As it appears in the prosecution history, the full segment reads (material underlined is that deleted by Envirotech):

> *With respect to the cited prior art, it was pointed out that each of the patents to Robinson, Parker et al. and McBride relied upon a* forced hydraulic or mechanical agitation to obtain a growth or accretion of agglomerate particles *which were then forced upward by the fluid flow to a sludge or solids collector near the top of the liquid-solids contact zone. Such concept* is entirely contrary to the concept of applicant's invention, and would defeat applicant's purpose through action of fluid forces in shear which would disrupt and break up the dense clumps of agglomerates which form as a result of applicant's processing.

The portions deleted by Envirotech make clear that the remarks were directed to reactor-clarifiers of the prior art, in which agglomerate particles are "forced upward". That prior art did not deal with "thickeners" in which solids are settled by gravity in a *settling zone*. Indeed, that prior art was so remote from the claimed inventions that Envirotech presented no testimony whatever about them at trial.

Though its Memorandum Decision contains conflicting statements touching the matter, the district court was clearly influenced by the effort of Envirotech to construct of fog a false estoppel. The district court said, "Disclaimer of mechanical mixing to achieve good flocculation, made in the course of the prosecution of the Eis patent, would exclude mechanical mixing as an 'equivalent' as a consequence of this doctrine of 'file wrapper estoppel' ".

It is absolutely clear from the uncropped quote above, and from the prior art listed in the full quotation, that Eis' counsel was distinguishing from that prior art on the basis that Eis' inventions avoided mixing *in the settling zone*, and that counsel's remarks had nothing whatever to do with mixing of the slurry *before* it entered that zone. That fact is further confirmed by the submission, contemporaneously with the quoted remarks, of

claim 1 with its introduction of the slurry into the settling zone "without additional agitation" of the solids mass in that zone, of claim 8 with its additional step of "mixing producing a liquid slurry" to be introduced into the settling zone (a *claimed* step can hardly be held to have been "disclaimed"), and of claim 9 which makes no reference whatever to mixing. Confirmation resides also in the findings of the district court that the Eis process is one for *"settling* slurries of finely divided solids without reliance on mechanical agitation" (emphasis added) and that "counsel for Eis was not specifically referring to the mixing apparatus now described in the Emmett [Envirotech] patent and used [in the accused products]". Envirotech simply ignores the clear showing in the record which directly refutes its "estoppel" argument.

Envirotech, as the claims specify, avoids mechanical agitation where the inventions are, i.e., in the *settling zone*. Envirotech's "estoppel" argument is simply devoid of merit.

Distortion of the record, by deletion of critical language in quoting from the record, reflects a lack of the candor required by the MODEL RULES OF PROFESSIONAL CONDUCT, Rule 3.3 (1983), wastes the time of the court and of opposing counsel, and imposes unnecessary costs on the parties and on fellow citizens whose taxes support this court and its staff. A quotation containing deletions that so clearly distort the meaning and relevance of the quotation as to render it misleading will not in this court be encouraged by acquiescence.[12]

Costs

Because Envirotech's brief relies on a reverse statement of the law of infringement, ignores the numerous and unanimous contrary authorities called to its attention by Amstar's main brief,

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[12] In the words of Elihu Root, "[a]bout half of the practice of a decent lawyer is telling would-be clients that they are damned fools and should stop".

distorts a quotation, and presents an estoppel argument based on that distortion, Envirotech shall pay to Amstar an amount equating to double Amstar's costs on this appeal. Asberry v. United States Postal Service, 692 F.2d 1378, 215 USPQ 921 (Fed. Cir. 1982).

Remand

The case is remanded for consideration of an injunction against further infringement by Envirotech and for an accounting of damages "adequate to compensate" Amstar for infringement. 35 U.S.C. § 284.

Reversed and Remanded.

Davis, Circuit Judge, concurring and dissenting.

I concur in the result on the merits and in the opinion with the exception of the parts headed "*Envirotech's Brief*" and *"Costs"*, but dissent from the award of double costs though I certainly agree that the appellee's quotation from the prosecution file should not have been cropped.

IN THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF UTAH CENTRAL DIVISION

Civil No. C 79-0023J

AMSTAR CORPORATION, a Delaware corporation,

Plaintiff,

vs.

ENVIROTECH CORPORATION, a Delaware corporation and ENERGY FUELS NUCLEAR, INC., a Colorado corporation,

Defendants.

MEMORANDUM OPINION

The plaintiff in this action, Amstar, seeks damages, injunctive and other relief against the defendants for conduct which Amstar alleges to be patent infringement in violation of 35 U.S.C. § § 271 *et seq.*

Amstar, a Delaware corporation having its principal place of business in New York, is engaged (through its Enviro-Clear Division) in the business of making, using, offering for sale and selling Enviro-Clear™ high-capacity clarifier-thickeners. Amstar is the owner by assignment of the entire right, title and interest in and to U. S. Patent No. 3,523,889 issued in the name of Frederick G. Eis, and entitled "Method and Apparatus for Separating Liquids from Solids" (hereinafter cited as "Eis Patent").[1] The Eis patent was applied for on November 26, 1968 (Ser. No. 779,089) and was issued on August 11, 1970. It describes a process and apparatus designed to enable industrial enterprises to separate solids from a large volume of liquid over

[1] This patent is attached hereto as Appendix A.

a relatively short period of time. Far from letting muddy waters settle in their own good time, the Eis patent as embodied in the Enviro-Clear clarifier-thickener is a continuous flow process that takes advantage of the efficacy of chemical flocculating agents[2] in separating solids — especially finely-divided solids — out of a liquid suspension or emulsion, enhanced further by the design of the apparatus and by the specific steps taken in the process.

Amstar alleges that since 1975, defendant Envirotech has designed, built, operated and sold a competing piece of equipment, the EIMCO Hi-Capacity Thickener, which is constructed and operates in a fashion that infringes on the apparatus and process claims of the Eis patent. Amstar further alleges that defendant Energy Fuels Nuclear, Inc. (EFN) has purchased seven EIMCO Hi-Capacity Thickeners and has installed them in a counter-current decantation (CCD) circuit[3] at its uranium ore processing facilities and has operated them since May, 1980.[4]

In response, Envirotech and EFN plead that (1) these do not fall within Amstar's patent claims as properly limited; (2) that the Eis Patent is invalid in light of prior art as embodied in earlier patents and publications, as well as the general knowledge available to skilled persons working in the field of liquid/solids separation; and (3) that the Eis patent is

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[2] A flocculating agent is a chemical or mixture of chemicals which causes particles to cluster together in small, loosely held lumps or aggregates, often called floccules, or "flocs".

[3] In a counter-current decantation (CCD) circuit, uranium ore, for example, is washed in a series of thickeners. The thickened ore solids progress through the circuit in one direction, the overflow wash liquor in the opposite direction. See EFN plans, PX 111-113. The process conserves wash water and concentrates the decantation products in the counter-current overflow liquor. See *e.g.*, Testimony of Rosenbaum, Tr. at 560-564 and DX-208.

[4] Envirotech has agreed to indemnify Energy Fuels Nuclear and hold it harmless from liability for infringement, if any, of the Eis Patent.

unenforceable because of an alleged failure of the inventor and his attorney to disclose relevant information to the Patent Office.

This action was tried to the Court from June 22 through June 30, 1981. The evidentiary material in this matter is voluminous. Besides over 1,150 pages of trial transcript, this Court received over 300 exhibits: documents, diagrams, photographs and articles, altogether totaling over 4,000 pages of technical materials. Additionally, the parties offered demonstrative evidence through experiments performed on videotape and in the courtroom, and the Court joined the parties for an onsite inspection of the laboratory version of the Envirotech equipment at its Salt Lake City facility.

This Court took the matter under advisement at the conclusion of the trial, awaiting submission of supplemental memoranda by counsel. During the months since then, this Court has gained a renewed appreciation for the problems presented at the unique intersection of law and the applied sciences embodied in patent law. Determining whether a mechanism and process were novel and not obvious at a given point in time and whether a second mechanism and process are similar to or different from the first, requires the skill, knowledge and perspective of an engineer. Judges ordinarily are not engineers, and judicial resolution of this kind of dispute reflects one profession's best efforts to discern facts and events from the perspective of another.[5]

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[5] Cf. *Reiner* v. *I. Leon Co.*, 285 F.2d 501, 503-504 (2d Cir. 1960), *cert. denied*, 366 U.S. 929 (1961) overruled on other grounds *Digitronics Corp.* v. *New York Racing Ass'n*, 553 F.2d 740 (2d Cir. 1977) *cert. denied* 434 U.S. 860:

> The test laid down is indeed misty enough. It directs us to surmise what was the range of ingenuity of a person 'having ordinary skill' in an 'art' with which we are totally unfamiliar; . . . . To judge on our own that this or that new assemblage of old factors was or was not 'obvious' is to substitute our ignorance for the acquaintance with the subject of those who were familiar with it. . . . . (Learned Hand, J.)

I. PATENT LAW PRINCIPLES

Yet patent validity and infringement determinations also require attention to consideration of law and public policy. As Justice Black explained in *Sears, Roebuck & Co.* v. *Stiffel Co.*, 376 U.S. 225, 229-231 (1964):

> The grant of a patent is the grant of a statutory monopoly; indeed, the grant of patents in England was an explicit exception to the statute of James I prohibiting monopolies. Patents are not given as favors, as was the case of monopolies given by the Tudor monarchs, see The Case of Monopolies (Darcy v. Allein), 11 Co. Rep. 84 b., 77 Eng.Rep. 1260 (K.B. 1602), but are meant to encourage invention by rewarding the inventor with the right, limited to a term of years fixed by the patent, to exclude others from the use of his invention. During that period of time no one may make use, or sell the patented product without the patentee's authority. 35 U.S.C. § 271. But, in rewarding useful invention, the "rights and welfare of the community must be fairly dealt with and effectually guarded." Kendall v. Winsor, 21 How. 322, 329 (1859). To that end the prerequisites to obtaining a patent are strictly observed, and when the patent has issued the limitations on its exercise are equally strictly enforced. To begin with, a genuine "invention" or "discovery" must be demonstrated "lest in the constant demand for new appliances the heavy hand of tribute be laid on each slight technological advance in an art." Cuno Engineering Corp. v. Automatic Devices Corp., 314 U.S. 84, 92, 62 S.Ct. 37, 41 (1941), * * *. Once the patent issues, it is strictly construed. United States v. Masonite Corp., 316 U.S. 265, 280, 62 S.Ct. 1070, 1078 (1942), it cannot be used to secure any monopoly beyond that contained in the patent, Morton Salt Co. v. G. S. Suppiger Co., 314 U.S. 488, 492, 62 S.Ct. 402, 405 (1942), the patentee's control over the product when it leaves his hands is sharply limited, see United States v. Univis Lens Co., 316 U.S. 241, 250-252, 62 S.Ct. 1088, 1093-1094 (1942), and the patent monopoly may not be used in disregard of the antitrust laws, see International Business Machines Corp. v. United States, 298 U.S. 131, 56 S.Ct. 701 (1936); United Shoe

> Machinery Corp. v. United States, 258 U.S. 451, 463-464, 42 S.Ct. 363, 367 (1922). Finally, and especially relevant here, when the patent expires the monopoly created by it expires too, and the right to make the article — including the right to make it in precisely the shape it carried when patented — passes to the public. Kellogg Co. v. National Biscuit Co., 305 U.S. 111, 120-122, 59 S.Ct. 109, 114-115 (1938); Singer Mfg. Co. v. June Mfg. Co., 163 U.S. 169, 185, 16 S.Ct. 1002, 1008 (1896).
>
> Thus the patent system is one in which uniform federal standards are carefully used to promote invention while at the same time preserving free competition.

An apparatus, process or material will be entitled to patent protection only if it will "promote the Progress of Science and Useful Arts....." U.S. Const. Art. I § 8, cl. 8.

"Congress has particularized the standard of patentability by requiring that an invention be endowed with the qualities of novelty, utility and non-obviousness before being entitled to a legal monopoly." *Carson* v. *Bland*, 398 F.2d 423, 426 (10th Cir. 1968); see 35 U.S.C. §§ 101-103 (1976 ed.). The courts apply this standard of invention strictly "lest in the constant demand for new appliances the heavy hand of tribute be laid on each slight technological advance in an art." *Cuno Engineering Corp.* v. *Automatic Devices Corp.*, 314 U.S. 84, 92 (1941). This is especially so when a combination patent is at issue:

> Courts should scrutinize combination patent claims with a care proportioned to the difficulty and improbability of finding invention in an assembly of old elements. The function of a patent is to add to the sum of useful knowledge. Patents cannot be sustained when, on the contrary, their effect is to subtract from former resources freely available to skilled artisans. A patent for a combination which only unites old elements with no change in their respective function . . . obviously withdraws what is already known into the field of its monopoly and diminishes the resources available to skillful men.

Great Atlantic & Pacific Tea Co. v. *Supermarket Equipment Corp.*, 340 U.S. 147, 152-153 (1950). In a combination patent, "[t]he conjunction or concert of known elements must contribute something; only when the whole in some way exceeds the sum of its parts is the accumulation of old devices patentable." *Id.*, 340 U.S. at 152; see *Anderson's-Black Rock* v. *Pavement Co.*, 396 U.S. 57, 61 (1969); *Sakraida* v. *Ag Pro, Inc.*, 425 U.S. 273, 282 (1976). A combination of known elements must produce a "new or different function," *Lincoln Co.* v. *Stewart-Warner Corp.*, 303 U.S. 545, 549 (1938), one not "reasonably obvious to one with ordinary skill in the art." *Anderson's-Black Rock* v. *Pavement Co.*, 396 U.S. at 60.

The crux of the defendants' position in this case is the argument of "obviousness" of the process and apparatus reflected in the Eis patent claims. 35 U.S.C. § 103 expressly requires that to receive patent protection an invention must not be obvious:

> A patent may not be obtained . . . if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. . . .

In applying 35 U.S.C. § 103, a trial court first must ascertain the nature and scope of the substantive "prior art" — patents previously issued, professional and scholarly articles then published, etc. The similarities and differences between the prior art and the claims sought to be patented have to be identified. Finally, keeping in mind the prior art, the trial court must decide whether, notwithstanding any perceived difference, the patent claims in question would have been obvious to a person having ordinary skills in a field of endeavor to which the patent pertains. *Central Soya Co., Inc.* v. *Geo. A. Hormel & Co.*, 645 F.2d 847, 850 (10th Cir. 1981).

> Although the ultimate question of patent validity is a question of law, such terms as "nature and scope," "differences," "obviousness," and "ordinary skill" pose questions of fact, not law. *Graham* v. *John Deere Co.*, 383 U.S. 1, 17, 86 S.Ct. 684, 693, 15 L.Ed.2d 545 (1966); *CMI Corp.* v. *Metropolitan Enterprises, Inc.*, 534 F.2d 874, 880 (10th Cir. 1976).

Id. 645 F.2d at 850.

Amstar, as an assignee of an existing patent, approaches patent infringement litigation from a favorable position: under 35 U.S.C. § 282 (1976 ed.), a patent that has been issued is presumed valid, and if invalidity is asserted, the burden of establishing that the patent is not valid rests with the party asserting it. In *Sidewinder Marine, Inc.* v. *Starbuck Kustom Boats & Products, Inc.*, 597 F.2d 201, 205-206 (10th Cir. 1979), the U. S. Court of Appeals for the Tenth Circuit stated that although the statutory presumption of validity is rebuttable, the burden on an alleged patent infringer to rebut the presumption is a heavy one: the § 282 presumption can be overcome only by clear and convincing evidence. See also *Mumm* v. *Jacob E. Decker & Sons*, 301 U.S. 168, 171 (1937); *Oliver United Filters, Inc.* v. *Silver*, 206 F.2d 658 (10th Cir. 1953), *cert. denied* 346 U.S. 923. The policy basis for this very strong presumption of validity is reliance on the expertise of the Patent Office in determining whether the conditions of patentability have been met. *Central Soya Co., Inc.* v. *George A. Hormel & Co.*, 645 F.2d at 850.

In light of that policy, however, the presumption of validity itself may be weakened by evidence that the patent examiner did not have all of the relevant facts before him at the time the patent was issued. *Escoa Fintube Corp.* v. *Tranter, Inc.*, 631 F.2d 682, 691 (10th Cir. 1980). A recent decision of the Tenth Circuit held that the introduction of highly relevant but unconsidered evidence of prior art requires a "fresh assessment of all the art — new and old —" to be carried out by the trier of fact

without benefit of the presumption. *Sidewinder Marine* v. *Starbuck Kustom Boats and Products, Inc.*, 597 F.2d 201, 206 n. 6 (10th Cir. 1979). Accordingly, Envirotech and EFN have to some extent sought to prove that several prior art examples were more pertinent to the Eis patent claims than were the prior art examples considered and cited by the patent examiner. Cf. *CMI Corp.* v. *Metropolitan Enterprises, Inc.*, 534 F.2d 874, 880 (10th Cir. 1976).

As noted above, "[t]o be patentable, the machine or process must add to the existing art something new and useful which is not obvious to one of ordinary skill in the art pertaining to the subject matter," *King-Seeley Thermos Co.* v. *Refrigerated Dispensers, Inc.*, 354 F.2d 533, 537 (10th Cir. 1965), i.e., it must have novelty, utility and non-obviousness. 35 U.S.C. §§ 101-103 (1970 ed.). Concerning novelty,[6] or whether the Eis patent was "anticipated" by prior art, the challenging party must prove by

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[6] 35. U.S.C. § 102 provides, in pertinent part:

A person shall be entitled to a patent unless

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or

* * * *

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or

* * * *

(g) before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it. In determining priority of invention there shall be considered not only the respective dates of conception and reduction to practice of the invention, but also the reasonable diligence of one who was first to conceive and last to reduce to practice, from a time prior to conception by the other.

clear and convincing evidence that all of the elements of the invention or their equivalents are found in a single pre-existing structure or description where they do substantially the same work in substantially the same way. See *Scaramucci* v. *Dresser Industries, Inc.*, 427 F.2d 1309, 1313-1314 (10th Cir. 1970); 1 Deller's Walker on Patents § 57 at 237-243 (2d ed. 1964 & supp. 1983). Far from mounting that kind of challenge, Envirotech and EFN substantially concede the novelty[7] and utility[8] of the Eis apparatus and process, arguing instead that they are "obvious" in light of the prior art. 35 U.S.C. § 103.

II. LIQUID/SOLIDS SEPARATION

Before considering "obviousness," or Envirotech's other defenses, it proves helpful to review in general the historical and

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For a more detailed discussion of novelty and anticipation in patent law, see 1 Deller's Walker on Patents §§ 54-82 (1964 & supp. 1983).

[7] Except for a brief, vaguely descriptive portion of the testimony of Melvin Katzer relating to use of a 3-foot diameter demonstration clarifier/thickener at the American Mining Congress in the mid-1950's, Tr. at 599-601, Envirotech and EFN have not sought to establish that the Eis process and apparatus claims were anticipated by one *single* example of the prior art. The defendants' emphasis has been on the obviousness of the Eis invention in light of the prior art as a whole.

The Eis patent's novelty thus has not been refuted in any clear and convincing fashion. See *The Barbed Wire Patent*, 143 U.S. 275, 284 (1892); *McCullough Tool Co.* v. *Well Survey, Inc.*, 343 F.2d 381, 394 (10th Cir. 1965) *cert. denied*, 383 U.S. 933 (1966); see also *E. I. duPont de Nemours* v. *Berkley & Co., Inc.*, 620 F.2d 1247, 1261 (8th Cir. 1980) ("[U]nsupported oral testimony can be sufficient [to prove a prior use] but must be regarded with suspicion and subjected to close scrutiny."); *Miner* v. *T. H. Symington Co.*, 250 U.S. 383, 386 (1919).

[8] That the Eis patent describes "a useful invention capable of performing the functions for which it was intended and capable of producing good and satisfactory results which are beneficial to the arts and to the country," 1 Deller's Walker on Patents § 84 at 484-484 [sic] (1964), is not and has not been in serious dispute. See also *E. I. duPont de Nemours* v. *Berkley & Co.*, 620 F.2d 1247, 1258-1260 (8th Cir. 1980).

technical background to this controversy. Both Amstar and Envirotech manufacture equipment to serve a significant and widespread industrial need: the efficient separation of solids — especially very finely ground solids — from a liquid/solid mixture.[9] The instances in an industrial setting in which such mixtures are produced are numerous: sugar processing, coal-washing, mineral ore processing, waste water treatment and other similar tasks generate a large volume of liquid which carries tons of suspended solids.

This problem of liquid/solids separation has plagued industry for decades. Consequently, the problem has been the subject of continuous invention and engineering development over that same period. See *e.g.*, U.S. Patent No. 526,518 (E.W. Deming, 1894); U.S. Patent No. 867,958 (J.V.N. Dorr, 1907); U.S. Patent No. 1,140,131 (J.V.N. Dorr, 1915); U.S. Patent No. 1,480,379 (R.D. Elliott, 1922), DX-1; U.S. Patent No. 2,098,467 (W.W. Sayers, 1935), DX-2; U.S. Patent No. 2,185,785 (J.V.N. Dorr, 1935), DX-3; U.S. Patent No. 2,227,099 (E.B. Mallory, 1936), DX-4; U.S. Patent No. Re 21,940 (G.M. Darby, 1938), DX-5; U.S. Patent No. 2,289,112 (A.J. Fischer, 1940), DX-6; U.S. Patent No. 3,349,030 (E.S. Savage, 1967), DX-7; U.S. Patent No. 3,087,890 (D.J. Pye, 1961), DX-19; U.S. Patent No. 3,523,889 (F. Eis 1970), PX-1; U.S. Patent No. 4,055,494 (R. Emmett, 1977), DX-83.

The simplest technique for liquid/solids separation is use of a batch settling tank. (See Fig. 1.) A batch settling tank is filled, and the slurry is allowed to settle for the desired time. The thickened solids may be removed through a valve in the bottom of the tank, and the clarified liquid may be decanted, drawn off, either through a siphon (not shown), or through one or more outflow

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[9] The technical literature as well as the craftsmen in the industry refer to such mixtures, which often resemble very muddy water, as "slurries" or "pulp," or some similar term. This Court treats these terms as reasonably interchangeable.

EDITOR'S NOTE

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valves positioned on the side of the tank. Decantation continues until the liquid begins to draw sludge solids out with it. The outflow valve is then closed, and another batch is fed into the tank through the launder.[10]

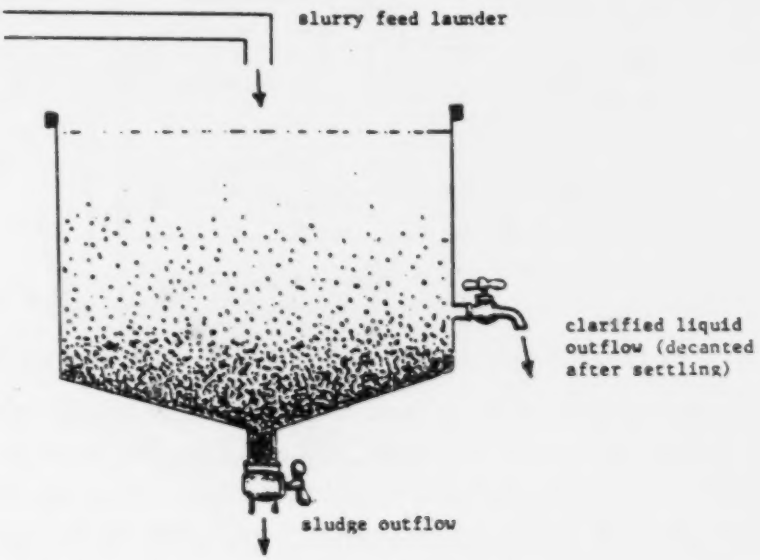

Fig. 1 BATCH SETTLING TANK

Of course, batch settling involves many tanks or considerable stopping and waiting — a limiting factor in an industrial process that might otherwise operate in a continuous flow.

Continuous settling may be conducted in similar cylindrical or rectangular tanks or vessels equipped with slowly revolving rakes which move the thickened sludge to a central discharge outlet. (See Fig. 2).[11] The slurry is introduced through a feedwell at the

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[10] G. Brown, et al, Unit Operations ch. 10 at p. 113 (1950), DX-115.

[11] In large tanks the mechanism for moving the rakes often is so constructed that the rake arms may be lifted off the bottom when overloaded (by an interruption of the outflow, or by "sanding out" of the sludge, or other problem). *Id.*

center of the tank. The slurry settles directly below the feedwell, forming the sludge that is withdrawn at the bottom. The clarified liquid rises in the tank to the periphery, where it overflows a circumferential weir and is drawn off.[12]

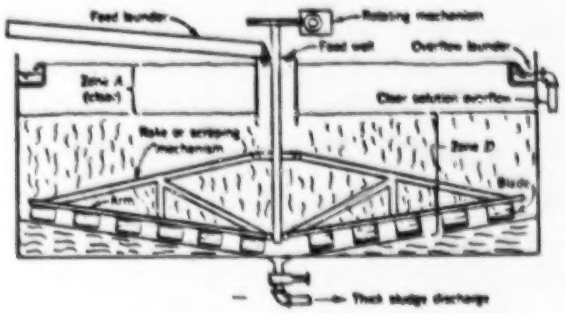

Fig. 2 CONTINUOUS FEED THICKENER/CLARIFIER

As in the batch settling tank, a zone of clear liquid forms in the upper portion of the tank (Zone A) as the particles fall towards the bottom, forming a settling zone of increasing density (Zone D). The tanks can be equipped with sensing devices that monitor the height of Zone D to avoid any spillage of solids into the overflow launder.

Continuous settling equipment may variously be referred to as a "thickener," or a "clarifier," depending upon its particular use in a process. A "thickener" is a continuous sedimentation tank used when a high solids underflow content is desired and clarity of overflow is secondary. A "clarifier" is the same equipment used with an emphasis on deriving a clear overflow liquor that is essentially free of solids.

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[12] *Id.*

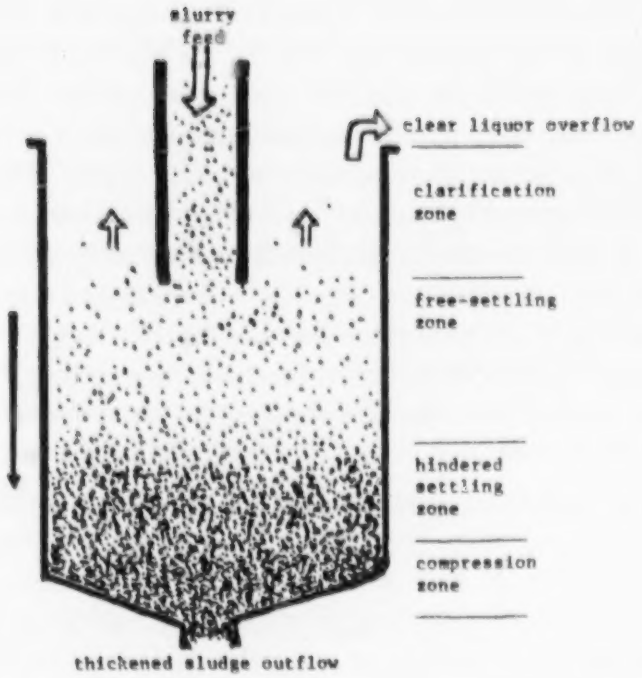

Fig. 3. ZONES IN A CONVENTIONAL THICKENER

The dimensions of conventional clarifier/thickeners, usually quite large, are determined by a number of factors, including particle size, slurry density, slurry viscosity and the upflow rate of liquid rising through the tank.[13]

> The suspended solids tend to settle down through the liquid which is relatively stagnant, although actually moving slowly radially and upward and rising from the compacting sludge.

G. Brown, et al., Unit Operations, ch. 10 at p. 114 (1950). Conventional clarifier/thickeners utilize a three-zone settling process. As slurry pours into the tank from the feed launder, the solids enter a *free settling zone*, where the particles settle at their

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[13] *Id.* See also Keane, "Sedimentation: theory, equipment, and methods," *World Mining* 44 (Nov. 1979); *id.*, pt. II, *World Mining* 48, 49-51 (Dec. 1979), PX-20J.

own rate based upon their sizes and density and the relative properties of the liquid. (See Fig. 3). As the solids settle, they increasingly come in contact with each other, forming a *hindered settling zone*. The interaction of the particles with each other slow their collective settling rate, "hindering" the thickening of the slurry. As the slurry thickens, particle interaction continues to increase, ultimately generating a compaction, or *compression zone* in which the rate-determining factor is much more the qualities of the solid-solid interactions than it is the nature of solid-liquid interactions dominant in the free-settling zone. The clarified liquid rises through these zones to form a fourth, or *clarification zone* with very little suspended solid content.

In conventional equipment, the rate of slurry processing is determined largely by the settling rates of particles in the free-settling zone; if the rate of upflow of the liquid exceeds the rate of which the free-settling particles fall, thickening ceases because the particles, buoyed up by the rising liquid, stop falling. Instead of forming the more compressed sediment layers, the slurry particles are washed out of the thickener/clarifier into the overflow launders, which frustrates the essential purpose of the equipment.

The rise rate of liquid in a thickener/clarifier may be determined by a simple formula:

$$v = \frac{V}{a}$$

where vertical velocity of the liquid (v) is equal to the volume of liquid rising at a given level (V) divided by the area of the thickener (a).[14] If the area of the tank is increased, rise rate diminishes. In a tank 60 feet in diameter and in one 30 feet in diameter, for example, a specific volume of liquid in the 60 ft. tank will rise at one-fourth (0.25) of the rate of the same volume rising in

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[14] Cf. Dahlstrom, "Solid-Liquid Separation," *Engineering & Mining Journal* 120, 121-122 (June 1980), PX 78-B.

the 30-foot tank.[15] The 60-foot thickener therefore, can handle four times the volume of liquid at the same rise rate.

As noted, the settling velocity of the particles must exceed the liquid rise rate for clarification and thickening to occur. In fact, "the settling velocity of particles must be sufficiently greater than the upward fluid velocity to prevent any increase in concentration in the clarification [i.e., free-settling] zone, for if "the settling velocity equals the upward fluid velocity, the particles will neither rise nor fall and the concentration of solids in the clarification zone will increase," reducing settling velocity until the zone itself rises, carrying particles up and into the overflow launders. G. Brown, et al., Unit Operations, *supra*, at 115.[16]

One of the ways that settling rates of solids may be enhanced is through the use of organic chemicals known as "flocculants,"

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[15] The formula for comparison of the liquid rise rates in two thickeners of different size would be

$$\left(\frac{r_1}{r_2}\right)^2$$

The rise rate thus decreases geometrically with the increase in thickener diameter $(2r)$.

[16] From this, it may be surmised that the following relationship may be used to estimate the required area of a clarifier that will thicken a specific weight of solids within a given time:

$$A = \frac{Q(F-D)}{pR}$$

Where A = area (sq. ft.) required to thicken the slurring to consistency of D.
D = parts of liquid to one part solids by weight in the sludge underflow.
F = parts of liquid to one part solids by weight in feed.
Q = mass of solids treated per unit of time (lb./hr.).
R = rate of settling of pulp of consistency F to consistency of D (ft./hr.).
p = density of fluid (lb./cu. ft.).

For example, if one wishes within an hour to process ½ ton of solids in a 12:1 liquid/solid slurry, thickening it to a 1:1 sludge, and lab tests indicate that this slurry will settle to that consistency at a rate of .3 ft./hr., and the density of the fluid is 73.53 lb./cu.ft., (equiv. to water), one would want a tank with an area of approx. 498.6 sq. ft. or a diameter of 25.19 ft.

or settling aids. A variety of compounds have been used in the past,[17] all of which in one way or another appeared to speed clarification by causing the suspended slurry particles to agglomerate into larger clusters which have a faster settling rate.

The 1950's witnessed the application of a selection of synthetic organic polymers of acrylamide or ethylene oxide to thickening/clarification problems. These compounds, marketed under various trade names, such as Separan™, or Polyox™, cause dramatic increases in flocculation and settling rates in a wide variety of contexts. The relative effectiveness of the polymer flocculating agents is easily demonstrated: taking, for example, two graduated cylinders of the kind one finds in a laboratory, each is filled with a sample of slurry (e.g., a 3:1 liquid/solid as coal solids slurry). A small amount[18] of polymer is added and carefully mixed with the contents of one cylinder. Both cylinders are then allowed to stand while a clock is started, permitting measurement of settling rates. The efficacy of the polymer is graphically apparent. After 1 minute 15 seconds, the treated slurry has settled significantly; the untreated slurry remains essentially in suspension (see Fig. 4A). After 1 minute 30 seconds, the treated slurry is nearly ready to be drawn off; little change is observed in the untreated cylinder. (See Fig. 4B).

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[17] The list of compounds has included guar gum, hide glue, casein from cow's milk, prickly pear cactus pulp extract, algin, Irish moss gum, gum arabic, starch, karaya, lignin and carboxymethyl cellulose. J. Clegg & D. Foley, eds., Uranium Ore Processing 173 (1958), DX-18; Beet Sugar Technology 218 (1971), DX-30.

[18] For this demonstration 11 parts per million (ppm) of polymer were used. "High-Order Flocculant Activity Spans Wide pH," *Chemical Engineering* 74 (Mar. 24, 1958), DX-13. Often the operative concentration is even less. See *e.g.*, Rice, "The Use of Organic Flocculants . . .," Symposium, ASTM Spec. Pub. No. 207 (1956), DX-23.

Fig. 4A

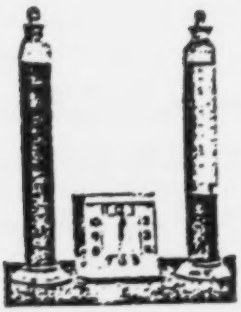

Fig. 4B

This kind of simple demonstration was used repeatedly to inform the industry of the relative value of the new polymers. See e.g., Testimony of D. J. Pye, Tr. at 473-474. Use of the polymers resulted in a notable increase in the slurry-handling capacity of conventional thickener/clarifiers.[19]

The mechanism of polymer flocculent action — not clearly understood for many years — may be summarized in these terms: The long, chain-like molecules of polyacrylamide (see note 21, *infra*) when mixed with a slurry, immediately begin to adhere or absorb on to the surface of the particles (see Fig. 5A).[20] As the particles brush and bump together in

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[19] *E.g.*, Rosenbaum & Clemmer, "Liquid-Solids Separations," in J. Clegg & D. Foley, Uranium Ore Processing 172, 187 (1958), DX-18.

[20] See *e.g.*, J. Singley, "Theory and Mechanism of Polyelectrolytes as Coagulant Aids," paper presented at AWWA Seminar, Chicago 1972, DX-17; Dow Separan™ Booklet, 1961, DX-65; Betz Polymer 1420 Booklet, DX-66; Rice, "The Use of Organic Flocculants . . .," in Symposium, Industrial Water and Industrial Waste Water, ASTM Special Tech. Pub. No. 207, (1956), DX-23; R. Sequeira, "Water-Soluble Polymers as Settling Aids in the Sugar Factory," in Beet Sugar Technology 248-252 (2d ed. 1971), DX-30 (good discussion of polymer flocculation physics).

Fig. 5A

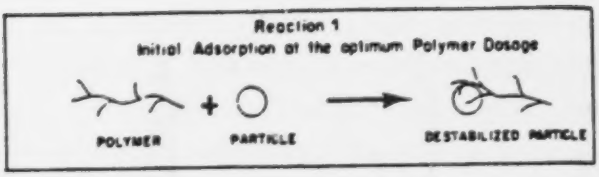
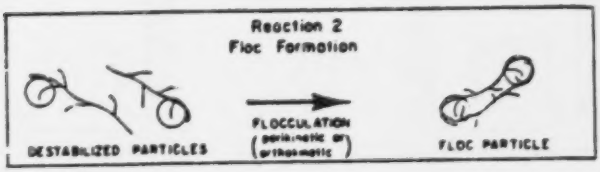


Fig. 5B



the liquid suspension, the long polymer filaments adsorb to the surface of additional particles, forming a floccule (see Fig. 5B). The large chain length of the polymer molecule makes it possible for them to adsorb on several particles at once yielding a larger, denser cluster that settles out of a liquid very quickly. Flocculation with a polymer reagent easily yields a "floc" that is ten times tougher — more cohesive — than that formed through use of alum, a simple flocculant, and that forms nearly 50 times faster. Rice, "The Use of Organic Flocculants and Flocculating Aids . . .," in Symposium on Industrial Water and Industrial Waste Water, ASTM Spec. Tech. Pub. No. 207, at 41, 45 (1956), DX-23.

Depending upon the requirements of a particular application, the polymer may be lengthened,[21] or altered chemically to have

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[21] "The molecular weights of such products can be controlled from about 30,000 to a maximum of about 10 million." Sequeira, Water-Soluble Polymers as Settling Aids . . . Chemical Development," in Beet Sugar Technology 248, 249 2d ed. (1971), DX-30. Considering that the acrylamide monomer unit has a molecular weight approximating 72, the polyacrylamide chains may range from 400 to 138,000 acrylamide units in length. Testimony has indicated that optimum length of polyacrylamide is in the 1,000,000 to 3,000,000 m.w. range, i.e., the 14,000 to 42,000-unit chains.

non-ionic, mildly ionic, or predominately ionic properties.[22] These compounds may be used with significant effect in acid, alkaline, or neutral chemical applications.

The effectiveness of the polymer flocculants is affected by a number of factors: dilution of polymer, dilution of slurry, speed and thoroughness of mixing flocculent with slurry, retention time and degree of agitation following flocculation, and the number of flocculent addition points. Dilute slurries flocculate more readily than do thick slurries; dilute flocculant solution — 0.01% to 0.05% by weight — often proves more effective than more concentrated solutions.

Polymer flocculation takes place rapidly. Once the flocs have formed, care must be taken to avoid handling the slurry in a manner which will break up — "shear" — the floccules once more into smaller particles.

As applied in conventional thickener/clarifier equipment, the polymer flocculants brought about a marked increase in process efficiency, with some operators reporting 21% overall improvements,[23] others reporting over 100% increase in the tonnage capacity of their thickener systems. *E.g.*, J. Clegg & D. Foley, eds., Uranium Ore Processing 187 (1958), DX-18; Rice, "The Use of Organic Flocculants and Flocculating Aids . . . ," in symposium on Industrial Water and Industrial Waste Water, ASTM Spec. Tech. Pub. No. 207, at 50 (1956), DX-23. The application of polymer flocculants has resulted in a potential reduction of thickener area of up to 50%. In the years following this development no major advancements or changes occurred in clarifier/thickener apparatus or operation until 1967, at which time Frederick Eis engaged in the work at Spreckles Sugar

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[22] *Id.*, at 249–250; Dow Chemical Co., Separan booklet, at 8 (1961), DX-65. The FDA approved polyacrylamide as a food additive in 1966. See 31 Fed. Reg. 5959 (Apr. 16, 1966), DX-37.

[23] See *e.g.*, "New Flocculents Yield Real Benefits," 64 *Chem. Eng. (No. 5) 162, 164 (May 1957), DX-14.*

which directly resulted in the Eis patent. It is against this background of prior art that the obviousness of the Eis patent claims must be assessed.

III. THE EIS INVENTION

Having observed the dramatic increase in settling rates achievable in the laboratory through use of polyacrylamide flocculants, Eis testified that he could not understand why much higher flow rates were not being obtained through use of conventional equipment. Abandoning the traditional design of thickening equipment, Eis tested a new design which introduced feed very near the bottom of the container, allowing a small distance for the agglomerated flocs to settle. Tr. at 140-142.

Eis observed surprising results. The small laboratory unit yielded unexpected overflow clarity, sludge density and overall flow rate. See Memorandum, F. Eis to R. McGinnis, Nov. 13, 1967, PX-4; see also Tr. at 142-143. He identified an apparent synergistic effect, combining the effects of settling and the effects of filtration by percolation of the slurry up through the compressing sludge layer. *Id.* at 2. The contrast between retention time in the new laboratory equipment and retention time in the conventional thickeners in use in the factory was striking and unexpected. Tr. at 145. While slurry materials may spend up to 180 minutes in a conventional thickener before being drawn off, the new laboratory design appeared to operate effectively with a retention time of minutes, or even less than a minute. Tr. at 145. The possibilities of a drastic reduction in retention time[24] were of special importance to Eis and his colleagues because of the adverse effects on quality of sugar solution caused by long retention times in clarifiers. Tr. at 145.

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[24] Laboratory tests indicated reduction of retention time by a factor between 10 and 200. See R. McGinnis, Research Project 256, Progress Report 1, Mar. 22, 1968, PX-5, DX-34.

Further testing was conducted using a larger laboratory model. Similar results were observed, including an average retention time of less than 5 minutes. See Research Project 256, "Studies in Sludge Removal and Liquor Clarification," July 2, 1968, PX-7, DX-41. Id., Aug. 23, 1968, PX-8, DX-44. A factory-scale sketch based upon the new design was prepared on May 20, 1968. See PX-6.

Soon thereafter, a patent application covering the Eis apparatus and process was submitted to the U.S. Patent Office. See Application of Frederick G. Eis. No. 770089, November 26, 1968, PX-2, DX-68. Initially the patent examiner objected to some aspects of the original claims in light of apparent similarities to prior art. Following further discussion of the Eis application and the rewriting of the claims, a patent was issued to Frederick G. Eis on August 11, 1970, U.S. Patent No. 3,523,889, PX-1, DX-25, Appendix A attached hereto.

The Eis patent as issued describes a high-speed process for settling slurries of finely divided solids without reliance on mechanical agitation or use of a free-settling zone as is found in conventional equipment. Instead, the patent describes a thickening/clarification process that depends upon: (1) continuous infusion of high-molecular weight polymer flocculating agent into liquid slurry to effect at least a partial flocculation or agglomeration of the suspended solids; (2) introduction of the freshly agglomerating slurry feed into a central location within a settling vessel which (3) contains a zone of previously formed "flocs," or agglomerated solids (i.e., a "sludge bed") within which zone the fresh slurry feed is (4) dispersed by using a flat deflector plate which arrests the vertical flow of the feed, deflecting it into a horizontal dispersion pattern within the flocculated layer; (5) interaction between freshly flocculated slurry and the previously formed agglomerates, which results in additional flocculation and concentration of the solids within the sludge bed, (6) forming at the bottom of the sludge bed a dense underflow of

solids which can be drawn off continuously without further agitation of the bed; (7) formation of a distinct interface between the mildly agitated sludge bed and the overlying zone of clear liquid which is continuously rising and drawn off through the overflow launders. (See Fig. 6A.)

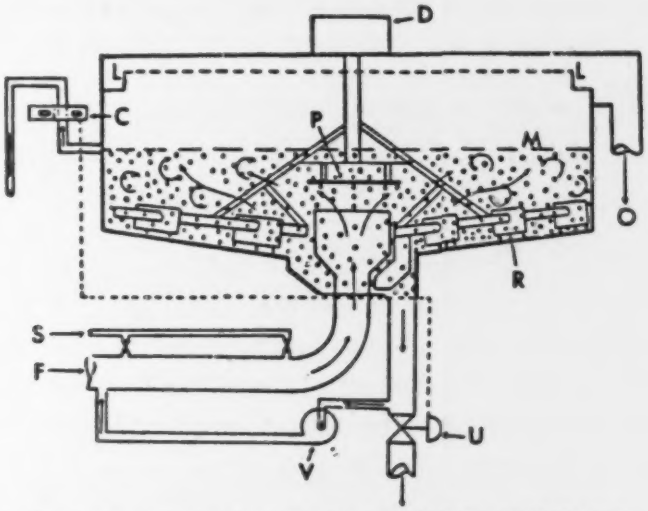

Fig. 2. Eis clarifier flow pattern. Key: D Rake drive, L liquid level, M mud bed level, C mud bed level controller, P deflector plate, O overflow, R mud rakes, S settling aid addition, F feed, V variable speed recirculation pump, U underflow control valve.

Fig. 6A THE EIS/AMSTAR ENVIRO-CLEAR THICKENER

The Eis apparatus may readily be supplied with slurry either through a feedwell rising from the bottom of the tank or one feeding from the top center of the apparatus. (See Fig. 6B & 6C). Of particular significance is the close proximity of the flat baffle plate to the mouth of the feed well,[25] and the noticable[sic] flaring of the feedwell mouth as an additional device for reducing the vertical flow of the incoming slurry.

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[25] See *e.g.*, Memorandum, R. Emmett to R. Fontaine, Nov. 11, 1977, PX-42, at 4; U.S. Patent No. 3,523,889 (F. Eis Aug. 11, 1970), PX-1, DX-25, 55 at col. 5-6; Testimony of J. Muldowney, Tr. at 106–109.

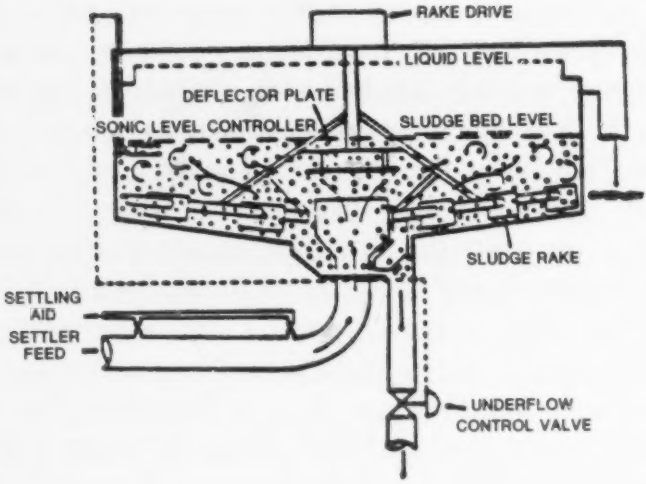

Fig. 6B

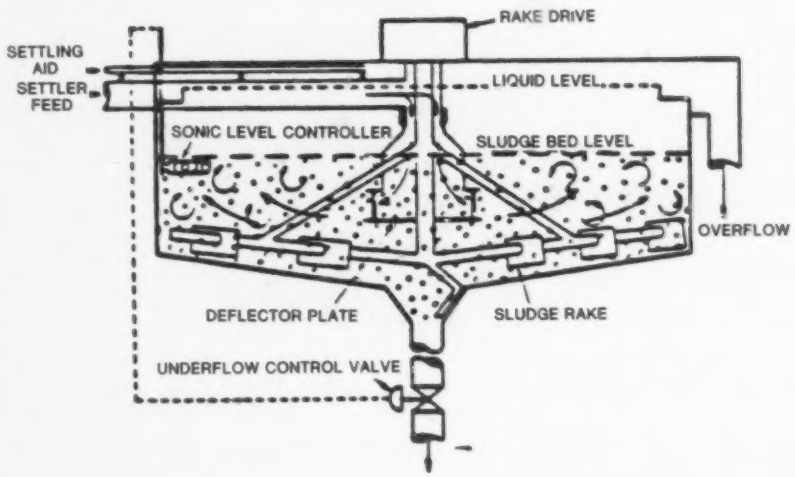

Fig. 6C

As tested and applied in the sugar industry in which it was developed, the Eis Enviro-Clear™ apparatus yielded striking results in terms of capacity vs. thickener area.[26] In one sugar

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[26] *See also* Bonney Report on Comparative Tests, July 3, 1969, PX-9; Minutes of Technical Review Meeting, Dec. 15-16, 1969, PX-10;

factory application, Enviro-Clear™ equipment was used to thicken sludge sufficiently to eliminate bacterial action that caused an odor problem that had been persistently troublesome for years. M. Rychkun, "Enviro-Clear Settler on Beet Flume Water Clarification at the Manitoba Sugar Co., Ltd." unpub. paper, Am. Soc. of Sugar Beet Tech. (1974) PX-18D. As applied to water treatment in coal processing at United States Steel, the Enviro-Clear™ thickener produced "overflow clarities and underflow concentrations at least as good or better than free settling thickeners at the same flocculant dosage, and handle[d] at least seven times the volume rate." A. Terchick, "The Application and Utilization of the Enviro-Clear Thickener in a U. S. Steel Coal Preparation Plant," Preprint No. 74-F-343, Soc. of Mining Eng. of AIME, at 9 (1974), PX-19C, 258 *Transactions of SME* 148, 151 (June 1975), PX-19D; see also "Coal Preparation Innovations," *Coal Age* 278, 280 (Mid-May 1975) PX-19E; "New Clarifier/Thickener Boasts Output of Older Coal Preparation Plant," *Coal Age* (Jan. 1976), PX-19F. Five twenty-foot diameter Enviro-Clear™ thickeners were installed in a uranium processing counter-current decantation (CCD) circuit at Rocky Mountain Energy Co.'s Bear Creek Mill at Douglas, Wyoming.[•] The plant was the first to use Enviro-Clear™ thickeners in a uranium CCD circuit and performance was equivalent to conventional thickeners requiring far more surface area. The small dimensions of the Enviro-Clear™ equipment allowed installation of the thickeners in the mill building itself, facilitating easier maintenance, better operator attention, lessening interference by winter weather and reducing heat loss. Jackson, "Rapid building program puts RMEC into production

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O. Bonney & F. Eis, "Use of Flocculating Agents in Thickeners," in Beet Sugar Technology 253-257 (2d ed. 1971), PX-13A; 17 Int'l Sugar J. 265-268, 295-297 (1971) PX 13B; McGinnis, "Moses Lake — Largest Sugarbeet Factory in the Western Hemisphere," *The Sugar Journal* 19-21 (May 1973) PX-13E; K. Foo, et al., "new Clarifier/Thickener Installed at Fort Gary Factory," *The Sugar Journal* 28-30 (Aug. 1973), PX-13F.

of U_3O_8 in Powder River Basin," *Engineering/Mining Journal* 76, 78 (Oct. 1977), PX-20A. See also Lang, "Assessment of New Technology at Bear Creek Uranium Co.," unpub. paper presented to American Mining Congress, Las Vegas 1978, at 9 PX-20F, PX-20H; Ewaschuk, "Use of the Enviro-Clear Thickener at Quirke Mill," unpub. paper presented to Ann. meeting, Canadian Mineral Processors, Jan. 1977, DX-96.[27] As tested using leached uranium ore tailings at a facility in Evanston, Wyoming, a 17-foot diameter Eis clarifier handled the same flow capacity as a 100-foot conventional thickener, with comparable overflow and underflow solids content. See Memorandum, "Operation of a 17-ft. Diameter Enviro-Clear Clarifier on Acid-leached Uranium Whole Ore Tailings . . . ," Aug. 5, 1976, PX-11, see also photograph, PX-14, attached hereto as Appendix "C".

The Eis innovations were of special significance to the sugar industry because of the short retention time required. In sugar processing, the conventional retention time of 60 to 180 minutes aggravated sugar quality control problems. It is common in the industry to treat sugar juice/pulp mixture with lime (CaO) and carbon dioxide to remove a number of impurities. Often the mixture is heated to enhance the lime reactions.

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[27] It is interesting to note one reaction by an Envirotech official to Amstar's success with the Eis invention:

> Enviroclear either has a great item here or they have rewritten the laws of gravity or they are a little optomistic[sic] about their capabilities of their machine.

Memorandum, G. Geiger to O. Hopkins, Aug. 1, 1977, PX-63. Another official at Envirotech commented in 1977 that —

> [W]e have known for some time that EnviroClear was making inroads in [the uranium CCD] market . . . , but we also knew at the same time there was very little operating history and *it was a new concept which had to be proven* and the verdict was still undecided.

Memorandum, S. Robbins to K. Paulson, Oct. 13, 1977, PX-69 (emphasis added).

Treatment with hot alkali over an extended period of time, however, creates a new group of impurities. The lime degrades the invert sugar[28] content of the mixture into darkly colored organic acids[29] which turn the juice yellow, or brown. The lime forms salts with the acids in the juice, creating an additional impurity.

The drastic reduction in retention time that accrues from use of the Eis process yields a significant decrease in invert sugar degradation as evidenced both in odor and concentration of lime salts. In a 1971 article in *The International Sugar Journal*, Eis and others reported a 25-30% reduction of coloring matter and a 36-50% reduction in lime salts as a consequence of using the new clarifier. 73 International Sugar Journal 265-268, 295-297, DX-52. Others have reported similar reductions in sugar degradation.[30] Amstar, as assignee of the rights to the Eis patent, proceeded to market the Eis Enviro-Clear™ clarifier/thickener

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[28] The bulk of the sugar extracted from sugar beets or cane is sucrose (C_{12} H_{22} O_{11}), commonly known as table sugar. Sucrose is a disaccharide composed of two simpler sugars, glucose (a/k/a dextrose, C_6 H_{12} O_6), and fructose (a/k/a levulose C_6 H_{12} O_6). These simpler sugars are present in sugar juice extracts and are also produced by reaction of lime with sucrase.

[29] [A]s a result of action in the hot, alkaline medium, the invert sugars dextrose and levulose are decomposed in a complex fashion, resulting in yellowing or browning of the juices, with the formation of acids or their salts, such as brown glucinic (C_{12} H_{22} O_{11}?), reddish apoglucinic (C_9 H_{10} O_5?), brownish saccharumic (C_{14} H_{18} O_{11}?), brown mollasic (C_6 H_6 O_3) and various dark-colored so-called humic acids, of which a typical formula is C_{60} H_{52} O_{24} (COOH); formic, acetic, lactic and carbonic acids may also be present.

R. A. McGinnis, "Beet Sugar," at 211, DX-54.

[30] See *e.g.*, Havighorst, "Clarifies Faster in Less Space," *Food Engineering* 57, 58 (Dec. 1970), PX-18A; Ash, "Short Detention-Time Clarifier Boosts Sludge-Processing Results for British Sugar Factory," *Filtration Engineering* (Jan/Feb 1973), PX-18B.

here and abroad. Most purchasers of Enviro-clear equipment had been manufacturers in the sugar industry.[31]

As Amstar's marketing efforts expanded into the coal and minerals industries, the Enviroclear equipment attracted considerable attention from engineers and technicians at Envirotech. The Envirotech specialists were at first skeptical of Amstar's claims.[32] Great effort was expended in gathering data and direct observations concerning the Enviroclear equipment, particularly in pilot applications at coal and uranium ore mills[33], and at the Colorado School of Mines.[34] The available information was analyzed in an effort to discern the mechanism by

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[31] For a table of Enviro-Clear installations as of mid-1976, see "Product Plan for the EIMCO BSP Hi-Capacity Thickener," July, 1976, Table 4, at p. 1-14 *et seq.*, PX-55. At least 60% of domestic sugar manufacturers use Enviro-Clear thickeners. Testimony of Eis, Tr. at 1016.

[32] See *e.g.*, Memorandum, D. Dahlstrom to D. Hegyan, Nov. 8, 1973, PX-35A; Memorandum, D. Dahlstrom to C. Silverblatt, Oct. 11, 1974, PX-36A ("... I believe we should do some work to determine if this principle has any reality to it.... [and] to determine if this system is any good ..."); Memorandum, D. Dahlstrom to J. Paulford, Oct. 15, 1974, PX-36C; Memorandum, J. Wilhelm to C. Silverblatt, Aug. 5, 1975, PX-38; Memorandum, B. Emmett to C. Garnett, Sept. 3, 1975, PX-39D.

[33] See *e.g.*, Memorandum, D. Hegyan to D. Dahlstrom, Nov. 20, 1973, PX-35B; Memorandum, D. Dahlstrom to D. Hegyan, Nov. 30, 1973, PX-35C; Memorandum, G. Smith to file, Oct. 5, 1974, PX-37A; Memorandum, R. Summerhays to D. Wells, May 4, 1979, PX-37B; Memorandum, C. Garrett to G. Smith, June 13, 1975, PX-39A; Memorandum, G. Smith & C. Garrett to Distribution, Aug. 20, 1974, PX-39B; Memorandum, J. Stenbridge to R. Summerhays, Feb. 22, 1977, PX-41; Memorandum, R. Emmett to R. Fontaine, Nov. 11, 1977, PX-42; Memorandum, C. Garrett to G. Smith, Sept. 23, 1975, DX-78; Memorandum, D. Lillie, "The Enviro-Clear Thickener," May 5, 1975, PX-21B; A. H. Ross Letter and Memorandum, Nov. 4, 1977, PX-21C.

[34] See *e.g.*, Memorandum, D. Dahlstrom, to C. Silverblatt, Oct. 11, 1974, PX-36A; Memorandum, D. Dahlstrom to C. Silverblatt, Oct. 11, 1974 PX-36-B; D. Dahlstrom, J. Paulford & W. Johnson, Oct. 15, 1974, PX-36C; Memorandum, D. Dahlstrom to D. Hegyan, Oct. 15, 1974, PX-36D; Memorandum, R. Summerhays

which the Enviro-Clear™ clarifier/thickener operates, all with an eye towards development of a competing piece of equipment.[35]

Envirotech specialists were also very interested in identifying problems encountered when the factory scale Enviro-Clear™ equipment was used in coal/minerals applications — the mainstay of Envirotech's thickener/clarifier business.[36]

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to D. Dahlstrom, Nov. 18, 1974, PX-36E. The Colorado School of Mines Research Institute's Evaluation of an Enviro-Clear Thickener, July 31, 1974, was also received into evidence. PX-22.

[35] See *e.g.*, Memorandum, D. Dahlstrom to C. Silverblatt, Nov. 21, 1974, PX-36F, Memorandum, R. Emmett to R. Downard, Sept. 8, 1975, PX-49A; Memorandum, D. Dahlstrom to R. Emmett, Sept. 15, 1975, PX-49B; Minutes of Hi-Cap]acity[sic] Thickener Meeting, July 8, 1976, PX-54; Memorandum, G. Smith to W. Johnson, Aug. 23, 1977, PX-55; Memorandum, R. Walker to R. Summerhays, Aug. 24, 1977, PX-66; Excerpt from newsletter, PX-67; Memorandum, R. Klepper to Dick Smith, Oct. 11, 1977, PX-68; Memorandum, S. Robbins to K. Paulson, Oct. 13, 1977, PX-69; Memorandum, M. Wilcox to J. Brodie, Oct. 25, 1977, PX-70; Memorandum, K. Paulson to R. Aldrich, et al., Jan. 17, 1978, PX-73.

[36] See *e.g.*, Project Justification & Product Plan, EIMCO BSP Hi-Capacity Thickener, July 1976, at p. 1-21, PX-55; Memorandum, J. Paulford to Distribution, Mar. 12, 1975, PX-45. Memorandum, S. Postma to D. Wells, Dec. 30, 1977, PX-72 ("It appeared that Lamella and Enviro-Clear have a foot in the door in our own backyards."). Having expended such great efforts to discover if and how the Enviro-Clear method works, it is ironic at least to some extent for Envirotech to now assert that the Eis process was obvious to those skilled in the art. Perhaps, like a brilliant move in a game of chess, it seems so obvious and simple — after you have once seen it played. See *e.g.* Petrosian-Pachman, Bled 1961:

1. Nf3 c5 2. g3 Nc6 3. Bg2 g6 4. 0-0 Bg7 5. d3 e6 6. e4 Nge7 7. Re1 0-0 8. e5! d6 9. exd6! Qxd6 10. Nbd2! Qc7 11. Nb3 Nd5 12. Bf4 Qb6 13. Ne5! Nxb3 14. Nc4 Qb5 15. axb3 a5 16. Bd6! Bf6 17. Qf3 Kg7 18. Re4 Rd8 19. Qxf6+!! ("A brilliant sacrifice, which must have jolted Pachman out of his chair." — I. Chernev) Kxf6 20. Be5+ Kg5 21. Bg7! (1-0).

Officials at Envirotech soon committed significant resources to the development of what became the Eimco Hi-Capacity Thickener, an apparatus that its creators hoped would prove competitive in applications where high rate of flow and small thickener area would prove advantageous.

IV. THE EIMCO HI-CAPACITY THICKENER

The Envirotech apparatus resembles in its overall design the Amstar/Eis Enviro-Clear™ equipment, just as it resembles many of the conventional thickeners available from other manufacturers, such as Dorr-Oliver. (See Fig. 7.)

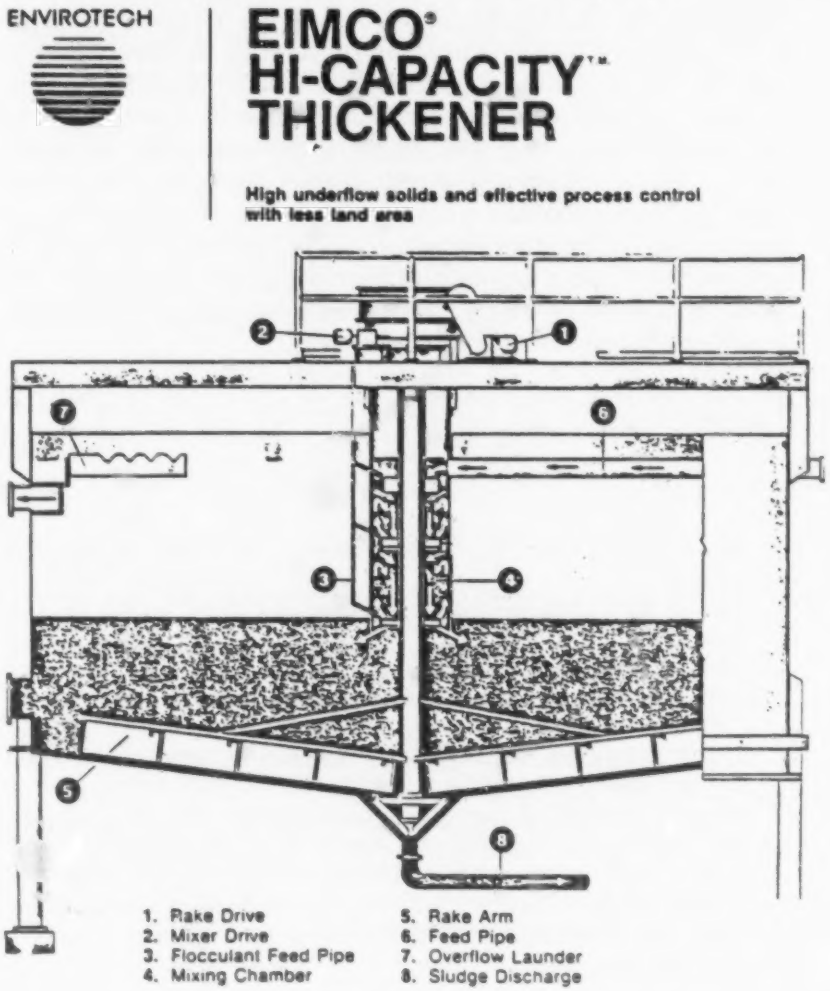

Fig. 7. A DIAGRAM OF THE ENVIROTECH HI-CAPACITY THICKENER (PX-80B)

In developing the Envirotech device, the technicians sought to exploit the efficacy of the various high-molecular weight polyacrylamide flocculants, but to do so in a way that differed from and hopefully was superior to the process used in the Enviro-Clear™ equipment. Its designers placed a high premium on designing a process and mechanism that would optimize the mixing of flocculants with the incoming slurry. From the Envirotech standpoint, a great mix is necessary to achieve great results:

> The previous work which has been done in flocculating both filter feed and thickener feed slurries has indicated that the reagent *can be blended more effectively if some form of mechanical agitation is used,* in preference to merely injecting the reagent. This is particularly true in launders, when, despite relatively high velocities, laminar flow tends to occur, and upper layers of slurry do not mix with the lower layers. This requires a larger dosage of flocculants in actual practice to accomplish what was expected from small scale test work. *Using a mechanical mixing device,* it should be possible to duplicate much more closely on a full-scale, the flocculation conditions produced in laboratory testing, and thereby conserve on the use of reagent.

Project Justification and Product Plan for the EIMCO BSP Hi-Capacity Thickeners, July 1976, at p. 1-24, PX-55 (emphasis added).[37] Rice, "The Use of Organic Flocculants . . .,"

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[37] See also Memorandum, R. Summerhays to Distribution, Oct. 22, 1976, PX-59:

> Based on a considerable amount of test work in this field, it has been determined that addition of the flocculant *with a properly operated, staged, mechanical mixer* in the center column provides near optimum flocculation.
> [Emphasis added.];

D. King, "Thickeners," in A. Mular &n[sic] R. Bhappu, Mineral Processing Plant Design (2d ed. 1980), PX-77, at 571:

> Very thorough mixing and dispersing of flocculant and slurry are required to substantially reduce thickening area required. The EIMCO Hi-Capacity Thickener *helps optimize flocculant mixing by mechanically mixing feed slurry and polymer* and then injecting the feed into the pulp blanket.
> [Emphasis added.]

Symposium, Industrial Water and Industrial Waste Water, ASTM Special Tech, Pub. No. 207, at 41, 46 (1956), DX-23:

> One of the primary requisites in the use of these new [polymer] aids is rapid complete dispersion of the material throughout the water stream being treated. Incomplete mixing often results in adsorption of most of the polymer on only a small portion of the flocculated turbid matter. This can result in high turbidity in the coagulator effluent.

Rather than relying upon simple injection of flocculant into the slurry feed before it entered the tank, Envirotech sought to test a means of mechanically stirring flocculant and slurry with sufficient force to produce excellent floc formation but not so forecful[sic] as to destroy flocs once formed.[38] J. Rosenbaum & J. Clemmer, "Liquid-Solids Separations," in J. Clegg & D. Foley, Uranium Ore Processing 172, 1980 (1958), DX-18 ("the flocculant must be disseminated uniformly throughout the slurry without degrading the floccules. Intense agitation to distribute the reagent for maximum effectiveness degrades the fragile floccules, and thus defeats its own purpose.")

This emphasis on quality of mix led to construction of feedwells with three or four chambers in which impeller blades mounted on a central shaft spin flocculant and slurry together, and in which vertical baffle fins mounted on the walls of the

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[38] See *e.g.*, R. Summerhays, "The Technology and Performance of the Hi-Capacity Thickener," unpub. paper presented to Society of Mining Engineers, AIME, Apr. 17-19, 1979, PX-76, at 2-3:

> Although a mixer can impart considerable shear to suspensions, it can also blend two streams, uniformly and rapidly, a prime requirement in flocculation with polymers. A reasonable balance between this destructive shear and good blending can be obtained by proper choice of impeller, mixing speed and retention time. Since flocculation is usually time dependent, the most desirable mixing means is in a series of mixing vessels, allowing flocculation to proceed at a controlled rate by introduction of a portion of the reagent in each of the mixing chambers. . . .

chamber break up any "swirling" motion, further enhancing the thoroughness of the mix.[39]

Additionally, Envirotech utilized an engineering concept drawn from a radically different design for thickeners, the Parkson-Lamella thickener (see Fig. 8),[40] and suspended in the

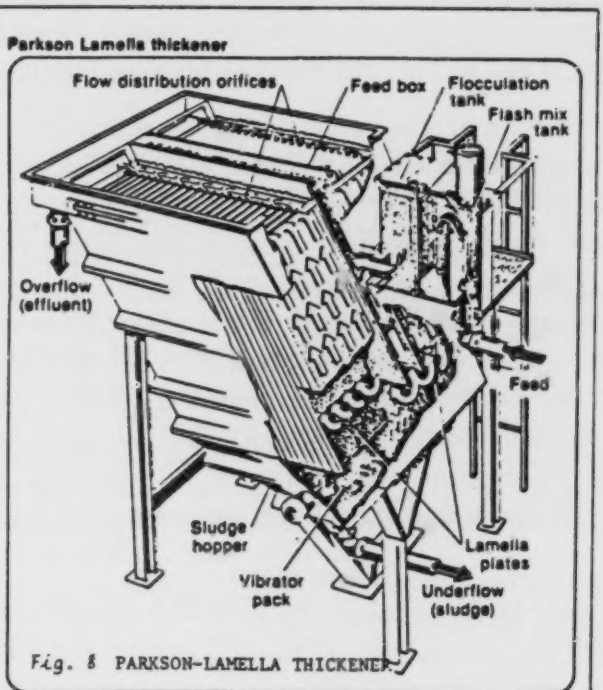

Fig. 8 PARKSON-LAMELLA THICKENER

[39] *Id.*, PX-76; D. Dahlstrom & R. Klepper, "Thickening and Clarification of Coal and Refuse Slurries," paper presented in Soviet Union, 1979, PX-78A, at 8; D. Dahlstrom, "Solid-Liquid Separation," 181 Engineering & Mining Journal 120, 123 (June 1980), PX-78B ("Rapid flocculant mixing, low shear impellers, multipoint addition of flocculant, and a high pumping rate combine to ensure rapid and homogenous contact of solids with the chemical."); Letter, R. Emmett to R. Shoemaker, Sept. 10, 1976, PX-57 at p. 2; Letter, B. Pawlowski to Ralph M. Parsons Co., Aug. 10, 1977, PX-64; U.S. Patent No. 4,055,494 (R. Emmett, Oct. 25, 1977), DX-83, at col. 4; Envirotech Corp., Disclosure of Invention, Feb. 5, 1975, PX-46.

[40] Keane, "Sedimentation: theory, equipment, and methods," *World Mining* 44, 51 (Nov. 1979), PX-20J. See also Hi-Capacity Thickener Product Manual, PX-83, at p. 8-B-2.

sludge bed around and below the feedwell a series of angled metal plates. These plates, often referred to as lamella plates, were understood to improve settling rates by reducing the interference in the settling of flocs caused by the upflow of the liquid slurry component. In conventional and Enviro-Clear thickeners, the settling particles must find their way down through currents of rising liquid. Using the angled plates is thought to lessen this interference by allowing particles to settle and fall along one face of a plate while the liquid rises along the opposite face of an adjoining plate. (See Fig. 9.)[41]

[41] *Id.*, at 51; D. Dahlstrom, "Thickening and Clarification of Coal and Refuse Slurries," paper presented in Soviet Union, 1979, PX-78A, at p. 10.

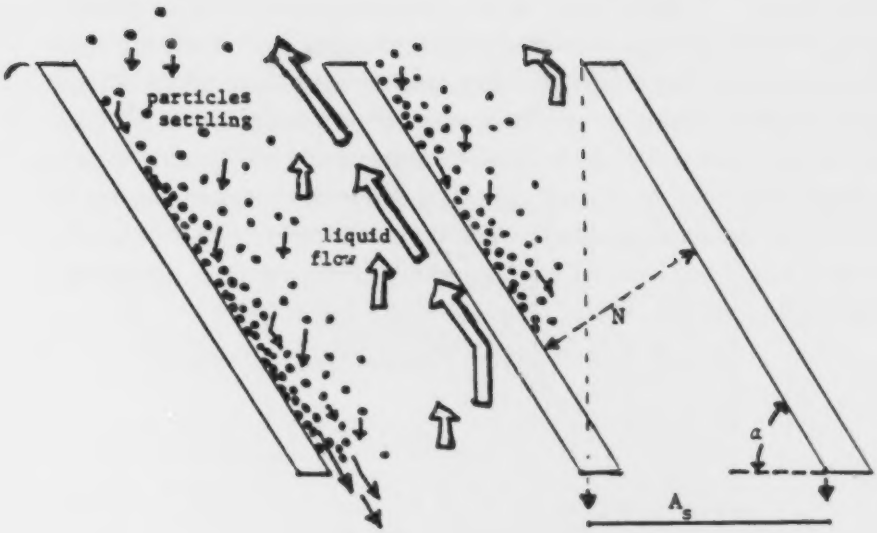

Fig. 9. EFFECT OF LAMELLA PLATES ON SETTLING PARTICLES AND UPFLOW OF LIQUID

As can be shown, the area that is theoretically available for separation is equal to the sum of the projections on the horizontal plane. This is defined as the specific surface area and is equal to:

$$A_s = \frac{\cos \alpha}{N}$$

where:

A_s = specific surface area per unit volume projected on a horizontal plane normally measured as meter^2/meter^3

α = angle of inclination to the horizontal

N = perpendicular distance between plates [in meters]

Obviously, A_s is increased as α and N are decreased. The angle α must be somewhat larger than the angle of repose of the sludge, so that it will slide down the plate. Inclination angles are usually 45 to 60° with 55 to 60 being the most common. The plate spacing must be large enough to accomodate the flow of liquid upwards while reducing interference and turbulence to prevent plugging. Usual spacings are 50 and 75 mm. . . .

Dahlstrom, "Thickening and Clarification of Coal and Refuse Slurries," paper presented in U.S.S.R., 1979, PX-78A, at 10.

Envirotech included the plates to avoid one criticism of the Enviro-Clear™ equipment: in actual factory use, some operators experienced difficulty in maintaining the sludge bed at the most effective level. The sludge beds lacked stability. The lamella plates, it was thought, would stabilize the sludge bed level by providing more plate area,[42] and thereby faster settling of solids, as the sludge bed rises in the tank,[43] and less effective plate area and slower settling, as the sludge bed level falls.[44] While not all drawings or models of the Envirotech Hi-Capacity Thickener

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[42] Memorandum, R. Emmett to L. Arabia, June 3, 1976, PX-53B at p. 2:

> The theoretical maximum thickening area [of the lamella plates] is equal to the product of the cosine of the angle of inclination and the total area of the inclined plate, or in the typical case, approximately 57% of the actual area. *We have added enough lamella plates in there to approximately double the total apparent area.* [Emphasis added.]

[43] In one five-foot diameter pilot plant, Envirotech engineers used 8 55° angle plates of approximately 3.8 square feet (sq. ft.) area for primary lamella (i.e., those in contact with the sludge bed). Those primary lamella increase the effective settling area by 2.2 sq. ft. each, or a total of 17.6 sq. ft. (or 90% of original thickener area) when the sludge bed reaches the top of the plates. Above the primary plates, 15 smaller secondary lamella potentially increased the thickener area by 11.4 sq. ft. (58% of original area), the main purpose of which was to improve clarity of the overflows. Project Justification and Product Plan, EIMCO BSP Hi-Capacity Thickener, July 1976, PX-55, at pp. 1-24 to 1-25.

See also Memorandum, R. Emmett to R. Summerhays, Sept. 21, 1976, PX-58, at pp. 2-3.

[44] See *e.g.*, Memorandum, C. Silverblatt/R. Emmett to L. Newman, Jan. 5, 1977, PX-60; Memorandum, R. Summerhays to Distribution, Oct. 22, 1976, PX-59; Letter, R. Emmett to R. Shoemaker, Sept. 10, 1976, PX-57, at p. 2; EIMCO Memorandum, "High Capacity Thickening, 6-202" PX-56; Letter, B. Pawlowski to Ralph M. Parsons Co., Aug. 10, 1977, PX-64; R. Summerhays, "The Technology and Performance of the Hi-Capacity Thickener, PX-76, *supra* note ____, at p. 00180; D. Dahlstrom, "Thickening and Clarification of Coal and Refuse Slurries," *supra* note 41, PX-78A, at pp. 8, 10-11; Monthly Report on Project No. 6-202, Hi-Capacity Sedimentation, (Nov. 1975), PX-48 at p. 00018; *Id.*, (Dec. 1975) PX-52; Memorandum, R. Emmett to O. Albertson, Dec. 4, 1975, PX-50.

have lamella plates included, the use of the plates remains an important design and process concept. See *e.g.*, E. Pakkala & G. LaRocque, "EIMCO-Envirotech Hi-Capacity Thickener Pilot Studies," Dec. 1977, PX-91, at 2.

See R. Summerhays, "Technology and Performance of the Hi-Capacity Thickener," PX-76, (1979), *supra* note 38, at p. 00182. See also *id.*, at 00193 (graph).

> The benefit from the inclined plates proved to be mainly in the dampening of solids feed rate fluctuations. As long as the level was maintained within a zone extending from just below the top of the plates to a point approximately in the center, excellent control was possible .... In one experiment, the plates were removed during the operation. Subsequently, the bed expanded, indicating that the average solids concentration in this zone is higher with the plates present. Also, a loss in clarity at the same flow rate was experienced when plates were removed, ...

On October 25, 1977, Robert Emmett, a leading project engineer at Envirotech, secured a patent on the Hi-Capacity Thickener design. See U.S. Patent No. 4,055,494, DX-83, attached hereto as Appendix "B".[45]

V. PATENT VALIDITY AND INFRINGEMENT CLAIMS

It cannot be denied that the preferred embodiment of the Envirotech apparatus and process (U.S. Pat. No. 4,055,494) bears a striking resemblance to the preferred embodiment of the Amstar apparatus and process described in the Eis patent (U.S. Pat. No. 3,523,899). Both sets of equipment perform the same ultimate task. Both use the same genre of polymer flocculating aids, the use of which was originally described by Pye (U.S. Pat. No. 3,087,890). Both gain savings in settling time through elimination of dependence on the free-settling zone, a common

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[45] Ironically, the Emmett patent does not list the Eis patent as a relevant prior art example. However, this court is not now called upon to evaluate the obviousness of the Emmett process in light of all the prior art. 35 U.S.C. § 103.

feature of "conventional" thickeners.[46] Both mechanisms draw thickened underflow from the bottom of the tank and clarified liquid from overflow wiers at the top of the tank — as do conventional Dorr-Oliver thickeners as well as other designs.

Likewise, one can compare various single elements of either invention with very similar elements in examples of the prior art. Much of the ground in this area is already well-trodden.[47] This Court has painstakingly reviewed the examples of prior art offered as exhibits as well as the testimony of expert witnesses in an effort to ascertain the "state of the art" in 1968 when Eis sought patent protection for his invention. In doing so, it proves important to recall that

> [W]e are required to evaluate the claimed subject matter as a whole against the teachings of the prior art references of the records. 35 U.S.C. § 103. References are evaluated by ascertaining the *facts fairly disclosed therein as a whole*. It is impermissible to first ascertain factually what [plaintiffs] *did* and then view the prior art in such a manner as to select from the random facts of that art only those which may be

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[46] See *e.g.*, Report on Research Project 256, Spreckles Sugar Co., Aug. 23. 1968, DX-44, at 1, 5; Memorandum, Research Project M-1, Jan. 7, 1969, DX-46; R. McGinnis. et al., "The Eis Rapid Clarifier," 73 *Int'l Sugar Journal* 265-268 (1971), DX-52:

> Studies have shown that in the Eis clarifier the free settling zone is bypassed, and virtually all thickening is in the zone of concentrated mixtures. This elimination of the zone of free settling accounts for the great acceleration of thickening provided by this unit. The presence of the flocculating aid increases the probability of particle agglomeration resulting from physical collisions of the small particles while the gentle rolling action of the sludge bed does not tend to destroy the agglomerates.

See also F. Eis, "Experiences with the Enviro-Clear System for Rapid Clarification . . .," 17 *Journal of the American Society of Sugar Beet Technologists* 105, 107 (Oct. 1972) DX-53.

[47] See *e.g.*, DX 1-14, 16-23, 65-66, 84, 101-117; see generally Memorandum, "Studies in Sludge Removal and Liquor Clarification," Spreckles Research Project 256, Apr. 7, 1970, DX-126, for a survey of the relevant literature.

> modified and then utilized to reconstruct appellant's invention from such prior art.

Application of Shuman, 361 F.2d 1008, 1012 (Cust. & Pat. App. 1966) (emphasis in original). The prior art "is not to be viewed with the aid of hindsight," *Simplicity Mfg. Co.* v. *Quick Mfg., Inc.*, 355 F.2d 1012, 1015 (6th Cir. 1966); it must be read "without the benefit of the [claimant's] teachings." *Application of Bulina*, 362 F.2d 555, 561 (Cust. & Pat. App. 1965).[48]

> The test of obviousness must be applied as of the time of the invention and not retrospectively as of the time of suit. "Many things may seem obvious after they have been made, and for this reason courts should guard against the use of hindsight. We must be careful to 'view the prior art without reading into that art the teachings of appellant's invention.' Application of Spork, 301 F.2d 686, 689 [49 C.C.P.A. 1039]." Monroe Auto Equip. Co. v. Heckethan Mfg. & Supply Co., 332 F.2d 406, 412 (6th Cir. 1965). The principle is well established. Goodyear Tire and Rubber Co. v. Ray-O-Vac Co., 321 U.S. 275, 279 (1944). . . .

Higley v. *Brenner*, 387 F.2d 855, 858 (D.C. Cir. 1967).[49]

Reconstructing as best one can the state of prior art of thickeners in 1968, this Court cannot say that the Eis process and apparatus as expressed in the claims of U.S. Patent No. 3,523,889 was obvious to a person skilled in that art. While elements of the Eis claims, if viewed in isolation, seem presaged by various prior art examples, the Eis patent did not secure patent protection for isolated elements of a process. The Eis protects a combination of elements, a *synergistic* combination,[50]

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[48] "To constitute prior art, they must teach the invention with clarity and explicitness," *Preuss* v. *General Electric Co.*, 392 F.2d 29, 32 (2d Cir. 1968).

[49] The defendants' approach to this case at times seems to depend heavily on hindsight. See e.g., Testimony of R. Emmett, Tr. at 757-814.

[50] To be a patentable invention, a combination patent must demonstrate "unusual or surprising results" in light of the relevant prior art. See *e.g.*, *Sarkisian* v. *Winn-Proof Corp.*, 688 F.2d 647, 649

one which taken as a whole amounts to much more than the sum of individual parts considered separately.

The entire process must be shown to be "obvious" if the process is to be found unpatentable. "It is not sufficient to show that some of the steps individually are obvious or old." *Santa Fe-Pomeroy, Inc.* v. *P&Z Co.*, 569 F.2d 1084, 1091 (9th Cir. 1978). It must be recalled that

> Generally when elements old in the art are combined together in a manner which secures a new and useful result in a more facile, economical and efficient manner, there is a patentable combination. . . .

EIMCO Corp. v. *Peterson Filters and Engineering Co.*, 406 F.2d 431, 434 (10th Cir. 1968). In *Colgate Palmolive Co.* v. *Carter Products, Inc.*, 230 F.2d 855 (4th Cir. 1956), for example, this same principle was applied to sustain the validity of a patent on a shaving lather in an aerosol can. "The elements — soap as lather, a can as a container, and gas liquified under pressure — were not new. What was new was the patentee's 'mixture of the right gases, with the right soaps in the right proportions, confined in a container under the right pressure, so that a lather satisfactory for shaving purposes [was] *** produced when the

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(9th Cir. 1982). The notion of "synergism" expresses a similar idea, i.e., a combination which taken together produces greater effects than the sum of the parts efficacy if considered separately.

The Eis patent describes a process that is far more effective than is conventional equipment using polymer flocculants, or would be an Enviro-Clear apparatus operated without benefit of polymer flocculants. Whether in this circuit the legal criterion is "synergism," or "unusual or surprising results," the Eis combination has satisfied the test. See *Norfin, Inc.* v. *International Business Machines*, 625 F.2d 357, 365 (10th Cir. 1980); *Plastic Container Corp.* v. *Continental Plastics*, 607 F.2d 885, 904-905 & nn. 46-48 (10th Cir. 1979); *True Temper Corp.* v. *CF&I Steel Corp.*, 601 F.2d 495, 506 (10th Cir. 1979); *Deere & Co.* v. *Hesston Corp.*, 593 F.2d 956 (10th Cir. 1979). Cf. *Rengo Co., Ltd.* v. *Molins Machine Co., Inc.* 657 F.2d 535, 544-545 & nn. 17-24 (3d Cir. 1981).

mixture was allowed to emerge.' *Id.* at 858." *Higley* v. *Brenner*, 387 F.2d 855, 859 (D.C. Cir. 1967).

Like *Santa Fe-Pomeroy*, *supra*, "[t]his is the type of case where the operative principle of the invention is obscure, but once perceived its design is relatively simple." *Id.*, 569 F.2d at 1095. However, "an invention will not be denied a patent because it embodies a solution which seems simple and obvious with the benefit of hindsight. *National Sponge Cushion Co.* v. *Rubber Corp.*, 286 F.2d 731, 735 (9th Cir. 1961) *cert. denied*, 368 U.S. 976 . . ." *Saf-Gard Products, Inc.* v. *Service Parts, Inc.*, 532 F.2d 1266, 1272 (9th Cir. 1976) *cert. denied*, 429 U.S. 896.

The defendants attempt to discount the innovative change reflected in the Eis patent as a mere extension of the use of synthetic polymer flocculants introduced in the 1950's. It seems odd that such an "obvious" corollary to the prior art in a competitive industry would be overlooked for more than a decade. It is odd, particularly in the sugar industry, where degradation of sugars due to long retention time in conventional clarifier/thickeners was a recognized problem. When introduced, the Eis Enviro-Clear™ unit was very soon a substantial commercial success, particularly in sugar industry applications. "The Supreme Court in *Graham* v. *John Deere Co.*, 383 U.S. 1, 86 S.Ct. 684, 15 L.Ed.2d 545 (1966), recognized that it was relevant to consider the elements of prior experimentation and failure together with long-felt need in the industry and commercial success in determining obviousness." *ESCOA Fintube Corp.* v. *Transfer, Inc.*, 631 F.2d 682, 695 (10th Cir. 1980); *Deere & Co.* v. *Hesston Corp.*, 593 F.2d 956, 962 (10th Cir. 1979) (commercial success and failure of others may be relevant in determining obviousness or non-obviousness); *Saf-Gard Products, Inc.* v. *Service Parts, Inc.*, 532 F.2d 1266, 1272-1273 (9th Cir. 1976) *cert. denied*, 429 U.S. 896 (circumstantial factors such as trade acceptance, commercial success, etc. may

be weighed in determining obviousness); *Higley* v. *Brenner*, 387 F.2d 855, 859 (D.C. Cir. 1967).

Was the Eis invention an "obvious" extention of prior art? Nothing in the way polymer flocculants were generally tested, demonstrated and applied in laboratory or factory settlings indicated the kind of results one could obtain if the Eis process was used. The graduated cylinder batch tests that were commonly used in the laboratory to provide the data used to calculate the dimensions of settling equipment[51] cannot easily avoid dependence on a free-settling zone. No account can be taken of the enhanced settling effect of interaction of freshly flocculated pulp with pre-formed flocs in an active sludge bed if one uses test methods lacking that interaction.[52] To accomplish laboratory sizing of Enviro-Clear™ and similar high-capacity thickeners, traditional procedures have been modified or abandoned—an

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[51] See e.g., Keane, "Sedimentation: theory, equipment, and methods," *World Mining* 48, 49-50 (Dec. 1979), PX-20J; R. Van Note, "Thickening," in Beet Sugar Technology 236, 246-248 (2d ed. 1971), DX-30; EIMCO Sedimentation Manual (Ca. July 1966), PX-33; J. Rosenbaum & J. Clammer, "Liquid-solids Separations," in J. Clegg and D. Foley, Uranium Ore Processing 172 (1958), DX-18; see also H. Coe & G. Clevenger, "Methods for Determining the Capacities of Slime-Settling Tanks," 55 *Trans. Am. Inst. Mining Met. Engineers* 356 (1916–1917); G. Kynch "A Theory of Sedimentation," 48 *Trans. Faraday Society* 166 (1952).

[52] When the Enviro-Clear thickener was introduced to mineral processing applications, Envirotech technicians using traditional tests found that the Enviro-Clear unit was operating at a rate ten times higher per unit area than would conventionally be predicted. Memorandum, D. Dahlstrom to C. Silverblatt, Nov. 21, 1974, PX-36F; see also Memorandum, J. Wilhelm to Distribution, Dec. 5, 1977, PX-71, at 4 ("It should be noted that the bench-scale testing techniques for sizing the Hi-Capacity Thickener have not been fully developed. We have a reasonable method for the sludges that have been pilot tested, but bench-scale correlations for overflow clarity have not been established."); Amstar "Background Material for Discussion of Opportunities for Promotion of Eis Settler," May 1969, DX-74, at 8 ("This unit consistently performed much better than is predicted by two empirical formulae often used to predict settler performance.").

exercise wholly dependent upon the teachings of the Eis patent. See Keane, "Sedimentation: theory, equipment and methods," *World Mining* 48, 51 (Dec. 1979), PX-20J:

> Equipment sizing recommendations for high-capacity thickeners vary according to the manufacturer. Enviro-Clear machines are usually sized by information derived from small-scale, bath-continuous laboratory testing in a specially designed laboratory unit. This unit is said to replicate actual operational parameters.
>
> [MCO-PMD division of the Envirotech Corporation has given several seminars outlining a laboratory batch sedimentation procedure which is said to result in sizing criteria for high capacity thickeners. This procedure involves *a modification of the standard laboratory batch sedimentation test by changing the method of pulp mixing* and subsequent flocculant introduction into the mixed slurry. [Emphasis added.]

See also, D. Dahlstrom, "Thickening and Clarification of Coal and Refuse Slurries," paper, presented in Soviet Union, 1979, PX-78A, at 14 ("when sizing a high-rate thickener, special attention must be given to flocculant addition. . . One of the most important aspects of the high-rate thickeners is the more efficient use of flocculant, resulting from dispersion of the flocculant in the feed stream *and introducing the feed under the sludge bed*. These same conditions *must be simulated as accurately as possible in bench-scale tests*." [Emphasis added]); . . . . , "Solid-Liquid Separation," 181 *Engineering & Mining Journal* 120, 121-122 (June 1980), PX 78B; see also Testimony of R. Emmett, Tr. at 861. J. Wilhelm & Y. Naide, "Sizing and Operating Continuous Thickeners," paper presented at AIME Annual Meeting, Feb. 18-22, 1979, New Orleans. Dorr-Oliver, another manufacturer of similar high-capacity equipment, recommends sizing of equipment through actual pilot plant testing. See Keane, *supra*.

Indeed, the teachings if[sic] the prior art as once synthesized by Envirotech run contrary to the teachings of the Eis patent. In

the EIMCO Sedimentation Manual, dated ca. July 10, 1966, PX-33, it is categorically declared that "[f]eed entering a thickener or clarifier should be discharged from the feed well into a pulp concentration *equal to that of the feed* for *optimum* opoeration[sic]." *Id.*, at p. 1-4 (emphasis added).

To construct the Enviro-Clear thickener, Eis necessarily ran afoul of this "rule" taught by prior art. "Long-accepted factors which discourage investigation into a combination of designs may be taken into account when determining obviousness." *John Zink Co.* v. *National Airoil Burner Co.*, 613 F.2d 547, 554 (5th Cir. 1980); see also *United States* v. *Adams*, 383 U.S. 39, 51-52 (1966); *Tights, Inc.* v. *Acme-McCrary Corp.*, 541 F.2d 1047, 1059 (4th Cir. 1976) *cert. denied*, 429 U.S. 980. That an invention is arrived at contrary to the understood teachings of the prior art speaks far more of novelty than of obviousness. As the U.S. Court of Appeals for the Tenth Circuit recently observed,

> When the teachings in the prior art must be ignored to reach a desired result, they become less pertinent to the determination of obviousness.

Milgo Electronics Corp. v. *United Bus. Communications, Inc.*, 623 F.2d 645, 654 (10th Cir. 1980); see also *CMI Corp.* v. *Metropolitan Enterprises, Inc.*, 534 F.2d 874, 880 (10th Cir. 1976).

While the references and examples offered as prior art by the defendants are instructive, and perhaps should properly have been considered by the patent examiners who processed the Eis patent,[53] the record taken as a whole does not establish that the

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[53] While it is established that the statutory presumption of patent validity is weakened when it can be shown that pertinent instances of prior art were not considered by the Patent Examiner before granting the patent, see *e.g.*, *Deere & Co.* v. *Sperry Rand Corp.*, 513 F.2d 1131 (9th Cir. 1975), it is equally settled that "[a]lleged art that is cumulative to cited art does not weaken or destroy the presumption of validity." *Saf-Gard Products, Inc.* v. *Service Parts, Inc.*, 532 F.2d 1266, 1271 (9th Cir. 1976), *quoting Schnadig* v. *Gaines Manufacturing Co.*, 494 F.2d 383, 391 (6th Cir. 1974). While a number of prior art examples cited by defendants can be

Eis invention was "obvious" within the meaning of 35 U.S.C. § 103. This being the primary dispute concerning the Eis patent, this Court now affirms the validity of that patent, U.S. Patent No. 3,523,889.[54] See generally, *Central Soya Co., Inc.* v. *Geo. A. Hormel & Co.*, 645 F.2d 847 (10th Cir. 1981); *Escoa Fintube Corp.* v. *Tranter, Inc.*, 613 F.2d 682, 692–696 (10th Cir. 1980).

Amstar's claims regarding infringement by the Envirotech designs, pilot models and factory installations at EFN depend upon proof that the defendants use or sell the patented invention described in the Eis documents. The defendants must be using the *combination* of elements protected by patent in order to infringe on a patented combination. Amstar may not assert protection for one or another elements of the Eis patent taken individually. Many individual elements, such as use of high-molecular weight polyacrylamide as a flocculating agent, are by themselves reflected in the prior art. For Amstar to establish liability, Envirotech must be using and selling the synergistic whole, not merely selected parts.

The combinative nature of Amstar's patent rights effectively limits the scope of enforceable claims under the Eis patent. If Envirotech's combination of elements differs in a material way from that described by Eis, there is no infringement.

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said to be cumulative of the references cited by the Examiner, a few of them are not cumulative, and should logically be considered. See *e.g.*, U.S. Pat. No. 3,087,890 (D. Pye Apr. 30, 1963), DX-19. The presumption of validity thus weakened, this court's ruling holds the Eis patent not to be "obvious" based upon a preponderance of all the evidence as independently weighed and considered by this court.

[54] As this Court construes the documents, the Eis patent protects the specific *combination* of elements and apparatus described therein.

This court also determines that Eis and others did not wrongfully withhold any material information from the Patent Office at the time that the matter was under consideration. Compare *True Temper Corp.* v. *CF&I Steel Corp.*, 601 F.2d 495, 501-502 (10th Cir. 1979).

A crucial area of difference between the Amstar and Envirotech equipment is the use of sophisticated mechanical mixing to promote flocculation. The Envirotech device is constructed around the multichamber impeller mixing system; Amstar's Enviroclear equipment uses no mixing blades, relying instead upon inflow injection of flocculant solution into the feed launder or feed pipe using specially designed nozzles. (See Fig. 10.)

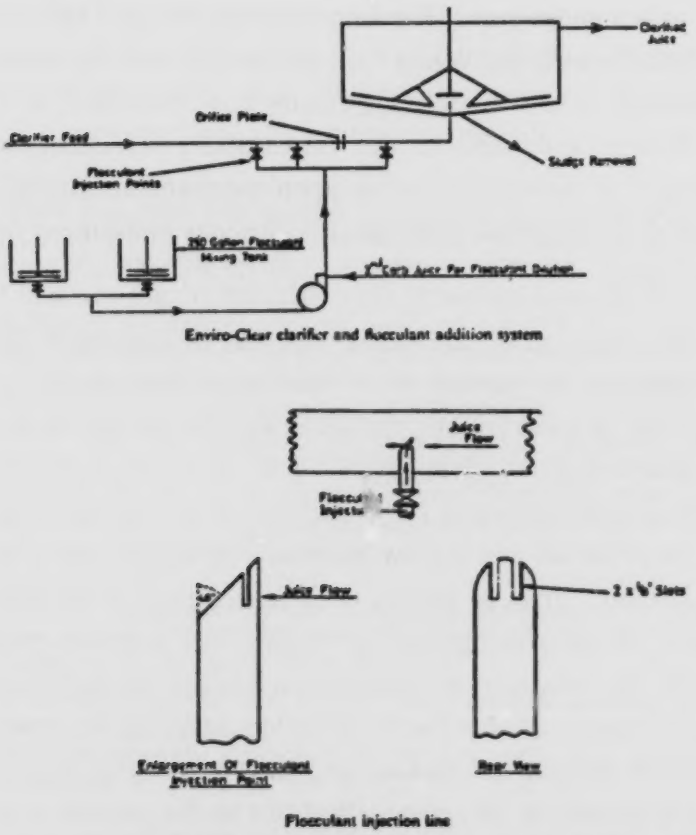

Fig. 10. SCHEMATIC DIAGRAM OF ENVIRO-CLEAR FLOCCULANT ADDITION SYSTEM; STRUCTURAL DIAGRAM OF INJECTION NOZZLE

Following initial rejection of the Eis application, the inventor emphatically argued that one reason why the Enviroclear

process was novel, non-obvious and patentable was its use of other than mechanical means:

> One point particularly stressed during the interview was the fact that applicant's claimed process and apparatus effects a separation of finely divided and suspended solids from an influent feed at an unusually rapid rate, *without relying upon* either the accretion or *growth of agglomerates through forced agitation* or the use of a free settling zone.

Remarks to Amendments of Eis Application Dec. 22, 1969, at 5, PX-2 (emphasis added). While counsel for Eis was not specifically referring to the mixing apparatus now described in the Emmett Patent and used in the Hi-Capacity Thickeners, it seems plain that Envirotech relies upon mechanical stirring to achieve good flocculation while the Eis/Amstar equipment does not.

While the doctrine of equivalents forbids infringement by a competing device or process if it "performs substantially the same function, in substantially the same way, to obtain the same result," *Machine Co.* v. *Murphy*, 97 U.S. 120, 125 (1878), the protection of that doctrine is circumscribed by limitations that a claimant imposes on his claims to meet the objections of the patent examiner. "It is, of course, well settled that an invention is construed not only in light of the claims, but also with reference to the file wrapper or prosecution history in the Patent Office." *Graham* v. *John Deere Co.*, 383 U.S. 1, 33 (1966). Disclaimer of mechanical mixing to achieve good flocculation, made in the course of the prosecution of the Eis patent, would exclude mechanical mixing as an "equivalent" as a consequence of this doctrine of "file wrapper estoppel." See *e.g.*, *John Zink Co.* v. *National Airoil Burner Co.*, 613 F.2d 547, 556 (5th Cir. 1980); *Central Soya Co., Inc.* v. *Geo. A. Hormel & Co.*, 645 F.2d 847, 851-852 (10th Cir. 1981).

The Eis patent as issued makes no claim which by its terms encompasses mechanical mixing to achieve optimum flocculation. To even accept the argument that the Emmett apparatus is an equivalent, one would have to wholly disregard the positive effects of the mechanical mixing system. This cannot reasonably be done in light of all of the evidence. Other differences, such as the absence of a flared feedwell mouth, a specially positioned flat baffle plate stationed a short distance below the feedwell,[55] the use in many applications of the angled lamella plates to stabilize the sludge bed (as opposed to allowing the sludge bed to roll and percolate freely throughout the tank), point to a materially different combination[56] that achieves improved results when compared to conventional thickening equipment.

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[55] While it is true that several Envirotech documents and drawings refer to use of a flat plate to disperse the feed, see *e.g.*, PX-85B; PX-85C, PX-53B, st[sic] 3; PX-58, at 1079; PX-88, at 1 & Fig. 1; PX-89, at Fig. 1; PX-90A, at 2(?), or use a modified baffle plate design at the base of the feed well, see *e.g.*, PX-93A; PX-93B, the feed well design for the EFN facility was modified to be a square center well without a bottom. See Minutes of Meeting, Feb. 28, 1979, PX-102; Memorandum, C. Garrett to D. Wells, Mar. 1, 1979, PX-103; Diagram of Hi-Capacity Thickener for EFN, PX-107; Instruction Manual, PX-108. Envirotech's later designs do not include flat baffle plates or flared feed wells. See Diagrams, PX 114-120. The Eagle Coal and Dock Co. feed well was similarly modified following discussion with Enviro-Clear personnel. See Deposition of C. Silverblatt, Tr. at 376-380; compare PX-123 with PX-121. Consequently the equipment in question in this lawsuit does not use a flat baffle plate as described by the Eis claims. Testimony of R. Emmett, Tr. at 864-875.

Even where a feed well design might have some form of bottom, flange, or base plate on the impeller shaft, the function of the base plate is arguably dissimilar to the Eis baffle. See generally Testimony of R. Emmett, Tr. at 728-749. The effects of the mixing chambers, impellers and baffles cannot be ignored in making findings as to infringement. Cf. Tr. at 1101.

[56] When Emmett and Klepper presented a paper on the EIMCO Hi-Capacity Thickener at the annual meeting of AIME, Feb.-Mar. 1978, Eis himself observed that the "mechanical mixing of flocculants with feed, the use of inclined plates, and the lack of appreciable solids concentration in the upper sludge bed" differed from Enviro-Clear equipment. Memorandum, F. Eis to J. Muldowney,

Envirotech as a matter of law is not free to duplicate the Amstar equipment and process. Amstar on the other hand does not hold a monopoly on the optimal use of polymer flocculants first described in the work of Pye and others. Envirotech may reach the same or a similar result, but several years of competitive enterprise have shown it a materially different road leading there.

This Court finds as a matter of fact that the Emmett/Envirotech invention is not the Eis/Amstar invention and concludes as a matter of law that the former does not infringe upon the plaintiff's valid rights in the latter within the meaning of 35 U.S.C. § 271. Amstar retains enforceable legal rights in its specific process, but not in the general result. It must be remembered that combination patents are to be carefully scrutinized, *Great Atlantic & Pacific Tea Co.* v. *Supermarket Corp.*, 340 U.S. 147, 152 (1950); *Graham* v. *John Deere Co.*, 383 U.S. 1, 18 (1960); *Escoa Fintube Corp.* v. *Trantor, Inc.*, 631 F.2d 682, 696 (10th Cir. 1980), and strictly construed, *Simplicity Mfg. Co.* v. *Quick Mfg. Inc.*, 355 F.2d 1012, 1014 (6th Cir. 1966). Even assuming that some initial diagrams and models of the Envirotech equipment followed too closely the outline first propounded by Eis, the paths of the parties have long since diverged and initial resemblance, now avoided, has done the plaintiff no cognizable injury or wrong. Plaintiff's complaint should be dismissed. Defendants' claims of patent invalidity

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Apr. 11, 1978, DX-50; see also Memorandum, F. Eis to J. Muldowney, Mar. 30, 1979, DX-71 ("The mechanical mixing device in the Emmett feed well is clearly different from the Eis feed well.").

The Eis, EIMCO Hi-Capacity, Dorr-Oliver, Parkson-Lamella and other conventional thickeners are all the same — if one ignores the material differences between them. Each apparatus and process must be fully considered in making the findings required by the patent laws. Using the plaintiff's general approach to equivalence one could readily conclude that ("with the exception of" a simple difference in design) a Phillips screwdriver is a standard screwdriver — a dubious result.

should be dismissed. In light of this Court's findings and conclusions as expressed herein, there exists no need to conduct further hearings on the damages issues previously severed for separate consideration.

DATED this 3 day of May, 1983.

BY THE COURT:

/s/ Bruce S. Jenkins
BRUCE S. JENKINS
United States District Judge

APPENDIX "A"

Aug. 11, 1970 F. G. EIS 3,523,889

METHOD AND APPARATUS FOR SEPARATING LIQUIDS FROM SOLIDS

Filed Nov. 26, 1968 2 Sheets-Sheet 1

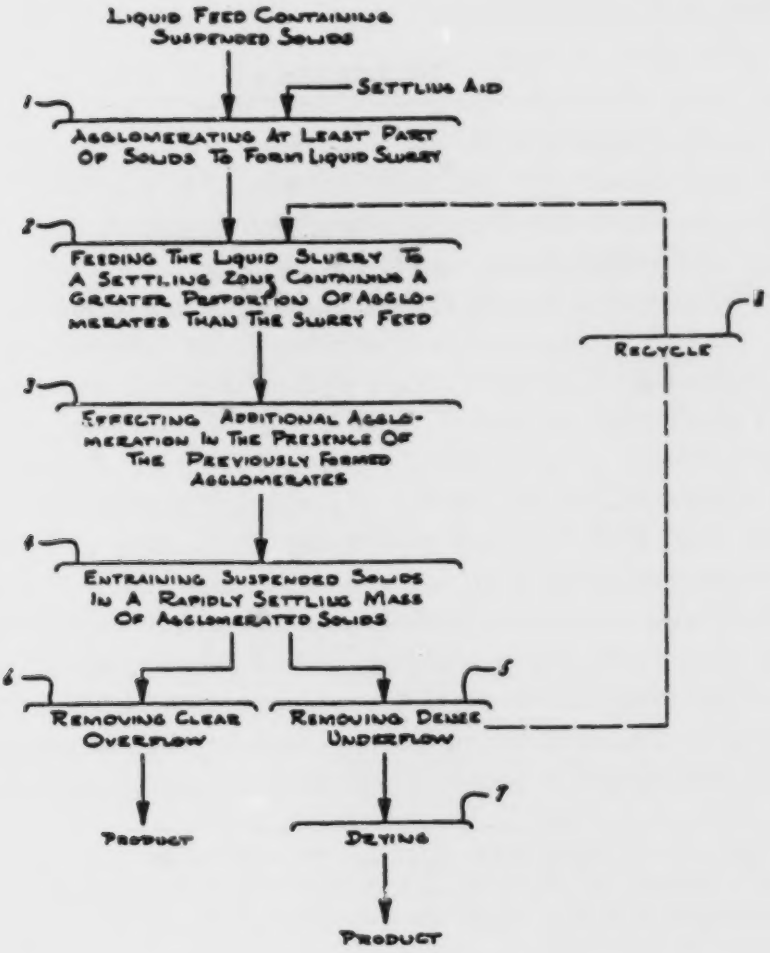

Fig. 1

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Aug. 11, 1970 F. G. EIS 3,523,889

METHOD AND APPARATUS FOR SEPARATING LIQUIDS FROM SOLIDS

Filed Nov. 26, 1968 2 Sheets-Sheet 2

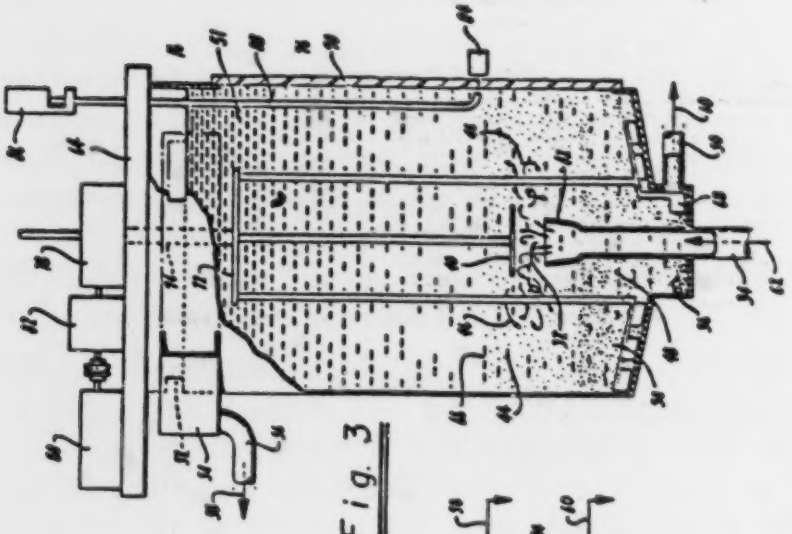

Fig. 3

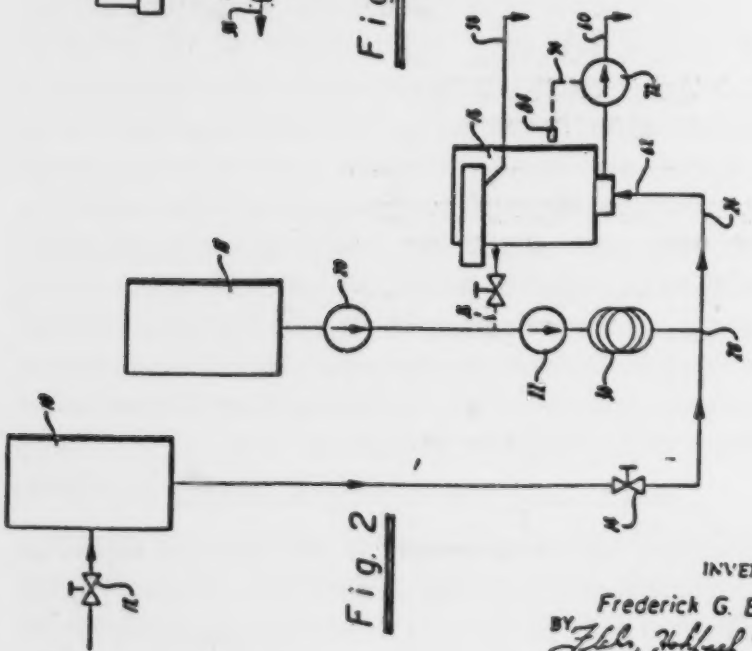

Fig. 2

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UNITED STATES PATENT OFFICE 3,523,889

Patented Aug 11, 1970

3,523,889
METHOD AND APPARATUS FOR SEPARATING LIQUIDS FROM SOLIDS

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a corporation of Delaware

Filed Nov. 26, 1968, Ser. No. 779,089
Int. Cl. B01d *21/01*

U.S. Cl. 210-20 11 claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for rapidly and continuously separating finely divided and suspended solid materials from liquids, at a predetermined controlled rate, involving initially agglomerating at least part of the solids through use of a settling aid and thereafter causing additional agglomeration of the solids to produce a rapidly setting, easily removable dense underflow of agglomerates and entrained solids. The additional agglomeration is carried out in the presence of previously formed agglomerates under controlled conditions, and in the absence of reliance on a free settling zone. The rate of removal of the dense underflow effects a degree of control ove. the settling bed depths and the density of the underflow. The clarified liquid is removed as a clear overflow. Both the clear liquid and the dense underflow are recoverable as end products, depending upon the particular liquid-solid system undergoing processing.

BACKGROUND OF INVENTION

This invention relates, generally, to methods and apparatus for continuously separating finely divided and suspended solids from liquids, and more particularly, to methods and means making possible the rapid agglomeration, settling and removal of

solids from liquids, following which the clarified liquid or separated solid is recoverable as an end product.

The present invention has particular application in the treatment and clarification of various liquid wastes, including commercial and municipal waste waters, such as factory waste liquors and partially clarified sewage. As is well known, problems arising from the presence of suspended solids are encountered with various types of industrial waste liquids. For example, waste liquids from beet and cane sugar manufacture, waste liquids from canneries, breweries, meat packing plants, rendering plants and other food processing plants, contain large amounts of finely divided and suspended solids as well as colloidal solids. In like fashion, liquid treating processes, such as waste and potable water treatments, lime-soda water softening and industrial water supply treatments, produce large amounts of effluent liquids containing waste solids. The chemical industries also produce large quantities of fluid wastes containing suspended solids. Examples include sulphite wastes from paper mills, cannery wastes, fermetation "slops," zeolite brines, etc.

In addition to the forgeoing[sic], it is frequently desirable to recover suspended solids from processed liquids for refining or re-use in the process. By way of illustration, it is frequently desirable to recover pigments or suspended particles of coal from aqueous suspensions derived from factory operations. It likewise is frequently desirable to process effluents in pharmaceutical operations for the recovery of valuable products, as well as the removal of undesirable byproducts. In short, there is a general widespread need for satisfactory procedures useful in the processing of aqueous effluents of all types to facilitate the removal of suspended solids.

Heretofore, processes developed for the purposes of separating suspended solids from liquid have generally involved use of filtration apparatus, such as rotary drum filters, or large slow-acting settling chambers, or both. The principal difficulty with

such separation techniques and apparatus has been the prolonged periods of time required to effect settling or separation, and the relatively large capacity and expense required for the separation equipment. These create even further problems arising as the result of an enforced inflexibility in the use and placement of machinery and equipment within an otherwise efficient factory design. The development of an efficient, rapid, easily controlled technique for separating finely divided and suspended solids from liquids is therefore highly to be desired.

SUMMARY OF INVENTION AND OBJECTS

Generally speaking, the present invention is directed to a method and means for the rapid, continuous separation of finely divided and suspended solid materials from liquids in an efficient, controlled manner. Broadly, the method of the present invention involves three general operations or phases: First, the agglomeration or partial agglomeration of the suspended solids in a liquid feed by the addition of a small amount of a settling aid. Next, the partially agglomerated liquid feed is introduced to a settling zone containing a relatively greater proportion of agglomerates per unit of volume to cause additional agglomeration of the solids and a consequent rapid settling of the solids together with entrainment of individual solid particles. Finally, the dense mass of rapidly settling agglomerates and entrained solids is rapidly removed as a dense underflow, at a controlled rate and in a continuous process, the clear liquid being simultaneously removed as a clear overflow. The broad processing is, of course, subject to a number of specific variations: Thus, the dense overflow can be partially recycled to the settling zone to control underflow densities as well as the nature of the solids removed from process; processing rates can also be varied as to time, turbulence, proportion, etc., to achieve various desired processing results.

Apparatus for carrying out the foregoing method provides for the introduction of the partially agglomerated liquid feed

directly to a settling zone within a settling vessel, comparable to the intermediate settling zone in sedimentation systems known heretofore. A particularly satisfactory apparatus includes standpipe means and arresting baffle means positioned within the settling vessel in such manner as to assure an unusually rapid settling operation, hereinafter described. In general, the settling method and apparatus of the present invention makes possible the effective separation of suspended solids from liquids in periods of time ranging from one-tenth to one-hundredth the time heretofore required to obtain equivalent results.

It is a general object of the present invention, therefore, to provide a method and means for the continuous separation of liquids from solids which achieve a more rapid and economical separation than has been possible heretofore with prior procedures and apparatus for such purposes.

Another object of the invention is to provide a relatively simple, highly effective means for treating waste waters and other liquid systems for purposes of separating and removing therefrom finely divided and suspended solids.

A further object of the invention is to provide a method and means of such character capable of use with a wide variety of liquid-solid systems to effect a complete separation of the liquid and suspended solid components.

Another object of the invention is to provide an improved method and means of such character that does not require complicated procedures or machinery, and which is adaptable to virtually any present-day system for treating systems of liquids containing suspended solids.

Another object of the invention is to provide an improved system for accomplishing the settling and removal of suspended solids which is highly efficient in that it removes virtually all of the suspended solids present in the liquid system.

Another particular object of the invention is to provide an improved method and means of such character which effects the separation of suspended solids from liquids in one-tenth to one-hundredth of the time heretofore required by prior systems.

Additional objects and advantages of the invention will appear from the following description in which the preferred embodiments have been set forth in detail in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a flow sheet illustrating a general method of carrying out the invention.

FIG. 2 is a schematic representation of a type of apparatus which may be used in carrying out the invention.

FIG. 3 is an enlarged schematic representation of a portion of the apparatus of FIG. 2 illustrating a particular embodiment of a settling chamber useful in carrying out the present invention.

DESCRIPTION OF PFERERRED [sic] EMBODIMENTS

Referring to the drawings, FIG. 1 represents a general flow sheet illustrating the main steps of the method of the present invention.

In step 1, a liquid feed containing suspended solids is continuously mixed with a quantity of settling aid (about 0.1 to 30 parts per million) to effect at least a partial agglomeration of the suspended solids. Settling aids capable of agglomerating the suspended solids in accordance with the present invention include the group of polyelectrolytes, and particularly the group of organic copolymers of acrylamide having molecular weights (estimated) at between two and three million. Polyelectrolyte settling aids of this type are generally disclosed, for example, in U.S. Pat. 3,025,236, 3,033,782, and 3,157,595.

In step 2, the liquid slurry containing agglomerated solids is continuously introduced as an influent feed to a zone of settling

within a separation vessel filled with a previously formed liquid slurry containing a relatively greater proportion of agglomerated solids per unit of volumn[sic] than the influene[sic] feed.

In step 3, additional agglomeration of the suspended solids is effected by the intermixing of the influent feed containing freshly agglomerating solids with the previously formed agglomerates in the settling zone. As noted below, this step is necessarily carried out simultaneously with the further processing outlined in steps 4, 5 and 6.

In step 4, suspended solid particles which have not coalesced into the agglomerates are entrained and physically removed as part of the rapidly settling agglomerates in the settling zone.

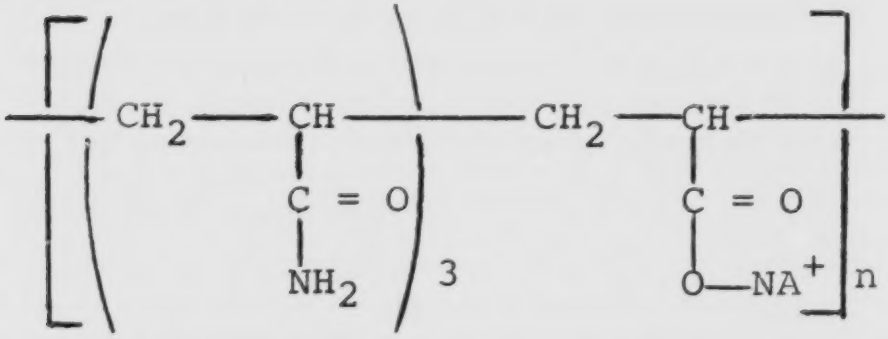
In step 5, the agglomerates and entrained solids are rapidly removed as a dense underflow from the settling zone simultaneously with removal, in step 6, of the clarified liquid as a clear overflow.

It will be apparent that the clarified liquid can be appropriately removed as an end product. The dense solid underflow can be further processed, likewise be removed, with or without further processing, for exmaple[sic], as by drying in step 7, to produce an end product. Alternatively, the clarified liquid and/or the solids may be discarded, burned or otherwise disposed of.

In step 8, represented by dotted lines in FIG. 1, the dense underflow can be recycled to become part of the influent feed of liquid slurry, the proportion of underflow and the rate of recycling being established to control the density of the underflow. As hereinafter described, such recycling provides advantages in many liquid-solid separation systems.

It is possible to employ various commercially available settling aids as the settling agents in step 1, including the group of high molecular weight polyacrylamide settling aids disclosed in the U.S. patents mentioned above. Polymers of this type having

molecular weights within the range from about two to three million are generally to be preferred. Particular polyacrylamide resins useful in carrying out the invention include a number of commercially available products. One such product is a high molecular weight synthetic copolymer containing amide and carboxylic groupings (Separan AP30, manufactured by Dow Chemical Co.) which has an approximate composition as represented by the following formula:



Another highly satisfactory settling aid available in the form of a modified polyacylamide resin is produced by the copolymerization of acrylamide with not more than 5-mol percent β-methacrylyloxyethyltrimethylammonium methyl sulfate. This polyacrylamide resin (for example, Betz polymer 1420, manufactured by Betz Manufacturing Corporation) is effectively used in amounts ranging from less than 1 to as much as 30 parts per million by weight of the liquid-solid system undergoing treatment. In general, it has been found desirable to use the polyacrylamides and like anionic polymers in the form of dilute aqueous solutions. The characteristics of these settling aids facilitates their use in systems where the pH is near neutral or higher. The dilute aqueous solutions are also easily added to the entering of aqueous feed, in desired proportional amounts, using convention proportional feeders and metering units. However, it should be understood that any settling aid which produces agglomeration of solids to a substantial degree can be employed

in the processing herein disclosed to achieve appreciable improvements over present practices.

FIG. 2 illustrates a system of apparatus suitable for carrying out the continuous process described above in conjunction with FIG. 1. A liquid feed containing suspended solids (for example, first carbonation juice from a beet or cane sugar factory), is introduced to a suitable defoaming tank **10** through a flow control valve **12.** Sugar liquors of this type normally contain up to 5 percent suspended solids (viz, calcium carbonate, vegetable fibers and like impurities) of particle size ranging from 0.1 to 100 microns. The defoamed liquid flows by gravity from the tank **10** through the flow control valve **14** to the settling tank **16.** Prior to entering the settling tank, an anionic polyeslectrolyte[sic] settling aid is metered from the tank **18** through the variable speed proportioning pumps **20** and **22** to the inlet feed line **24.** In the case of the Betz 1420 and Separan AP30 settling aids, the settling aid is generally added from a 0.5 percent stock solution with pipeline dilution by means of settler overflow, through the line **26,** to obtain a 0.025 percent solution at the point of addition to the feed (represented at **28**). To insure proper dispersion of the settling aid in the solution mixed with the feed, a relatively long length of conduit in the form of a coil **30** is advantageously employed.

The net effect of the addition of the settling aid to the solids containing feed is to initiate the fresh formation of agglomerates within the influent feed as it is introduced to the settling tank **16.** While the exact mechanism by which the polyacrylamide settling aids cause agglomeration of suspended solids is not known, it is strongly indicated that the settling aids (in the form of long straight-chain polymers) are adsorbed by the suspended solids, forming strong bonds between the polymer and the solid. After one end of the long molecule is adsorbed by a suspended solid particle, the rest of the molecule is still free in the suspension to be adsorbed by other particles. In the presence of many polymer

molecules in solution, the described action quickly results in agglomeration and floculation[sic] of the particles in the suspension. Moreover, because the long organic molecule agglomerates particles through an adsorption mechanism, the bond between the settling aid and the suspended particles forms quickly and substantially irreversibly. The agglomerates thus tend to hold together throughout the settling operation in the settling tank **16**.

As shown in detail in FIG. 3, the liquid feed in the form of a slurry containing freshly agglomerating solids, is introduced at a centralized position between the bottom and top of the settling vessel, represented at **32**. In the illustrated apparatus, this is accomplished by means of a standpipe **34** which passes through a well **36** provided in the bottom **38** of the tank to a height substantially above the bottom of the tank. In general, it is desirable that the point of entry **32** is at least six inches above the bottom of the tank. It has also been found desirable to arrest the upward motion of the influent feed immediately above the point of entry. This can be simply accomplished by a baffle or other arresting means **40** positioned closely[sic] adjacent and above the point of entry **32**. The upper end **42** of the standpipe may also be slightly flared to further assist in arresting the rate of flow of the influent feed at the point **32**. The net effect is to cause a gradual reduction in flow velocities coupled with a radial dispersion and intermixing of the influent feed with the concentrated solids-containing liquid in the settling zone surrounding the standpipe, generally represented at **44** in FIG. 3.

As previously noted, it is a feature of the present invention that the entering slurry of freshly agglomerating solids is introduced into the midst of a gently agitated, sedimenting, previously formed liquid slurry containing a relatively greater proportion of agglomerated solids per unit of volume than is present in the influent feed. Thus, as is particularly shown in FIG. 3, the feed percolating outward from the point of entry **32**

(arrows **46**) comes into contact with previously formed agglomerates of solid particles moving within the settling zone **44**. The effect of this intermixing of the newly agglomerating solids with the previously formed aglomerates[sic] is to cause additional agglomeration and coalescence of the solids into relatively large agglomerates which tend to rapidly sediment into a sludge zone **48** at the bottom of the tank.

In a preferred practice of the invention, the sludge falling into the zone **48** is rapidly removed as a dense underflow through a bottom outlet **50**, provided within the well **36**. Simultaneously, a clarified overflow **51** is removed from the top of the settling chamber through a peripheral opening **52** formed in an upper portion of the settling tank **16**. The clarified effluent is then collected in a trough **54** for discharge through a bottom outlet **56**. The simultaneous removal of the clarified effluent and dense underflow, represented by the arrows **58** and **60**, is carried out as a part of a continuous process in which the rates of flow depend generally upon the rate of feed of the influent liquid slurry, at **62**.

Referring again to FIG. 3, the deflecting baffle **40** can be adjustably mounted in the top **64** of the settling tank to facilitate variations in the point at which the upward movement of the entering feed is arrested. It has been found, for example, that the entering feed should be arrested at a point at least two inches above the point of entry **32** to insure a desired radial dispersion of the entering, freshly agglomerating solids. It has additionally been found desirable to have a settling bed **44** of sufficient depth to extend above the arresting baffle **40**, if the desired inermixing[sic] and formation of relatively large agglomerates is to be satisfactorily achieved. Thus, the upper boundary of the settling bed, represented at **66**, is preferably at least two inches above the deflecting baffle **40**. The depth and condition of the settling bed can be additionally maintained by means of a suitable mechanical rake **68**, positioned between the underflow discharge **50** and

the stand pipe **34**. As illustrated, the individual members of the rake can be mounted on depending supports **70** carried by a rotary disc and collar combination **72**, **74** associated with an adjustable support **76** for the baffle **40**. The rake is driven through the collar **74** by means of suitable gears contained in the housing **78** and cooperating with the drive or motor **80** through reduction gearing **82**.

If desired, the depth of the settling bed can be further maintained by means of a photo-eletcric[sic] cell **84**. As illustrated in FIG. 3, the photo-electric cell **84** is sensitive to light transmitted by a lamp **86** through a clear plastic rod **88**. A sight glass **90** is provided in the side of the settling tank to permit the photo-electric cell to freely scan the light transmissions of the rod **88**. In operation, the photo-electric cell **84** operates to control the underflow discharge pump **92** (see FIG. 2) through suitable electric circuitry, represented schematically at **94**. In general, the speed of the motor **92** is adjusted to slightly exceed the underflow requirements of the settling tank, with the amount of underflow being regulated by an on-off relay positioned within the circiut[sic] for the electric eye. When the settling bed increases to a height which brings it between the tube **88** and the eletcric[sic] eye **84**, the turbidity of the liquid causes the pump **92** to be turned on to withdraw the underflow at a faster rate than it is formed. However, as soon as the zone of turbidity of the settling solids passes to a level below the electric eye, the pump **92** is shut off to allow the height of the settling bed to gradually increase to its original level. In this fashion, the settling bed is maintained below a relatively stationary, clearly defined upper boundary, represented at **66**.

OPERATION

The overall operation of the apparatus just described, in carrying out the method of the invention, can be briefly summarized as follows:

The entering feed, after being defoamed as may be necessary in the defoaming tank **10**, is passed through the flow control valve **14** to the settling tank **16**. Settling aid from the storage tank **18** is metered through the proportioning pumps **20**, **22** and the mixing coil **30** to a point of mixing **28** with the entering feed. The entering feed, containing freshly forming agglomerates, enters the settling tank through the standpipe **34** unitl[sic] it reaches a point of arrested upward motion, represented at **32**. At this stage, the entering feed is surrounded by a previously formed liquid slurry containing a relatively large proportion of agglomerated solids per unit of volume than the feed and, upon being deflected radially outward by the baffle **40**, generates persistent contacts with these previously formed agglomerates. The effect of intermixing the freshly forming agglomerates with the agglomerates already present is to cause additional agglomeration and coalescence of the solids into relatively larger agglomerates, which tend to rapidly settle within the settling zone **44**. Generally the proportion of agglomerates within the settling zone **44** is comparable to that of an intermediate or slightly compacted zone within a conventional settling chamber, thereby insuring the desired intermixing of the feed with the surrounding agglomerates. The resulting relatively large agglomerates form a dense, free-falling mass of solids which effectively filters the feed liquid to remove suspended solid particles which have not yet coalesced into agglomerates. The clear juice in the meantime percolates up through a multiplicity of continuously changing channels formed within the settling zone **44**, providing a gentle agitation throughout upper portions of this zone. The effect of the described motion is to make possible a rapid setting of the relatively large agglomerates, even at relatively high rates of feed of solids-containing liquids to the settler. A dense underflow of agglomerates and entrained solid particles is thereafter rapidly removed through the bottom outlet **50** in response to the control of the underflow discharge pump **92**, the settling bed height being maintained throughout by the pump **92** in response

to the control of the photo-electric cell and lamp control unit **84**, **86**. Underflow removal is facilitated by operation of the rotary rakes **68** which function to move the agglomerates into the discharge trough or well **36**, where they are sucked into the discharge outlet **50**. At the stame[sic] time, clarified liquid passes up through the settling chamber and is discharged through the annular chamber **54** and top outlet **56**.

The above-described continuous method and apparatus for separating suspended solids from liquids has been found to be highly effective in achieving a rapid and complete separation of the liquid-solid components. By way of specific illustration, separations of first carbonation sludges from beet sugar factory operations (which normally require average settler retention times of the order of 80 minutes) are effectively accomplished with the separation technique herein described at average settler retention times of less than five minutes. Similar results are obtained, for example, in the separation of muds from main and flume waste waters, or in water softening by the lime-soda process, or in the treatment of various other liquids containing finely divided and suspended solids. In general, the processing of the present invention makes possible greatly reduced settling times, ranging from one-tenth to one-hundredth the time previously required for satisfactory results. The described processing and apparatus also provide advantages by virtue of the inherent simplicity in structure and operation (offering substantial reductions in factory shutdown and operating problems) as well as substantial reductions in capital expenditures for equipment. Of particular importance is the advantage offered by a substantially complete separation of solids from liquids made possible by the described method, consistent with the substantial reductions possible in time and expense.

EXAMPLES

In carrying out the processing according to the present invention, it has been found that the rate of influent feed to the settler

has a definite effect on the underflow density and the clarity or brilliance of the overflow. Thus, at a constant rate of addition of the settling aid, a reduction in the feed rate produces an immediate concurrent shrinking of the settling bed, whereas an increase in the influent feed rate results in a similar expansion of the settling bed. The effect of variations in the feed rate on underflow density and overflow clarity is illustrated by the data set forth in Table I below:

TABLE I. — FLOW RATE EFFECTS

Feed g.p.m.	Underflow Brix	Overflow clarity Kopke units
21	45	200
16	75	300
8	57	170
17	47	120
20	45	150
11	47	250
20	34	
21	35	200
13	52	140
18	44	
21	35	120

The foregoing table represents the results of separating suspended solids from first carbonation beet juices during four different processing periods) in a settling chamber of approximately 50 gallons capacity. The table shows that feed rates of 20 gallons per minute, or higher, can be continuously employed with very satisfactory separation of suspended solids from the liquids. Thus, the clarity readings expressed in Kopke units indicates clarity far above the norm experienced with the Kopke technique. Clarity by the Kopke procedure is determined by the ability to read lettering through an immersion depth of clear liquid in millimeters. Normally, a value of 100 is considered to represent excellent clarity. The table thus indicates clarity readings far beyond the scale of the instrument at feed rates up to 21

gallons per minute and higher. The readings in Table I were determined by interpolative measuring of the depth of immersion in millimeters to a point at which the lettering was still clearly visible. Table I further shows that the underflow density (measured in degrees Brix) was uniformly high, and consistent with the overflow clarity.

To determine the equivalent flow rates in gallons per minute per square foot of settling area, comparisons were made between a 50-gallon capacity settling unit and a smaller, laboratory model of 1550-milliliters capacity. Settling rates determined by comparison are summarized in Table II below:

TABLE II. — FLOW RATES PER UNIT OF AREA

Settling aid. p.p.m.	Equivalent flow rates in g.p.m. per ft.^{2} area		Underflow Brix	
	50 gal.	1,550 ml.	50 gal.	1,550 ml.
5	5.5	3.6	52-53	55
5	5.1	3.6	53	55
5	7.5	7.0	42	34
5	6.4	7.0	47	30
5	4.5	3.5	58-60	56
3	4.4	3.5	53-55	49
3	3.3	3.5	55	47-49
1.5	3.9	3.5	45	41
1.2	3.8	3.5	40	35

In the tests summarized in the foregoing table, the overflow from each test was unifo.mly brilliant at additions of polyacrylamide settling aid within the range from 3 to 5 p.p.m. It is further noted, at 1.2 p.p.m. of polyacrylamide settling aid, a Kopke clarity reading of the order of 100 was recorded for the 50-gailon capacity unit. Underflow density for each of the tests was also uniformly high, and consistent with the clarity of the overflow liquids. The foregoing Table II thus shows that feed rates in the general range of from 3 to about 8 gallons per

minute per square foot of settling area produce uniformly satisfactory results. In practice, feed rates ranging from 3 to as high as 10 gallons per minute per square foot of settling area have been employed with little change in the indicated results. With reference to a 50-gallon capacity settling unit, this fact is generally demonstrated by the results in the following Table III which sets forth gravimetric determinations made with respect to the amount of suspended solids, at various rates of flow of the entering feed:

TABLE III. — FLOW RATE EFFECT ON SUSPENDED SOLIDS

Fifty gallon settling unit					Factory settler	
	Underflow		Overflow			Overflow percent suspended dry solids
Feed g.p.m./ ft.^{2}	Brix	Percent suspended dry sol.	Kopke clarity	Percent suspended sol.	Feed g.p.m./ ft.^{2}	
8.1	49		300	.0049	0.37	.0098
6.7	55			.0098	0.37	.0073
5.4	55			.0040	0.37	.0045
4.7	55			.0073	0.37	.0045
3.8	52			.0045		
3.8				.0045		
9.2	46	23.4	200	.0128		
8.2	47	24.2	300	.0088		

In general, the foregoing table shows that the proportion of suspended solids retained in the overflow was equivalent to or less than normally retained with conventional settling units (i.e., a 9,000 cubic foot factory settler), even at the highest rates of feed. Moreover, operations at the highest rates of feed (and the shortest processing times) result in a retention of suspended solids in excess of that normally experienced in factory operations. On the other hand, clarity readings of the overflow

were substantially higher than those normally obtained by conventional operations.

It will be seen from the above description that a highly effective and comparatively simple method and means has been devised for rapidly separating suspended solids from liquid-solid systems. A method and means has also been provided whereby such liquid-solid systems may be treated in continuous processing for the removal of insoluble solids, in periods of time which are a fraction of the times previously required by conventional apparatus and which make possible major capacity increases over present factory settlers. Finally, it has been shown that the new method and apparatus are capable of adjustments with respect to variables in the processing to permit efficient utilization of both in various commercial and industrial applications, to produce the maximum beneficial result. These and other advantages are clearly within the scope of the invention as herein described and claimed.

I claim:

1. A continuous process for rapidly separating finely divided suspended solid materials from liquids at a predetermined controlled rate, comprising the steps of forming a slurry of solid agglomerates in an influent feed of liquid containing finely divided and suspended solids by the addition of a settling aid, forming a settling zone having a relatively stationary upper boundary and containing previously formed solid agglomerates, introducing said influent liquid slurry at a central position within said settling zone and centrally of said previously formed solid agglomerates, arresting the motion of the influent feed and displacing the same outwardly through said previously formed agglomerates to cause additional agglomeration of the solids and the formation without additional agitation of a dense settleable mass of the solids and agglomerates, continuously removing a dense underflow from beneath said settling zone at a rate to

maintain said relatively stationary upper boundary, and continuously removing an overflow of clarified liquid from above said upper boundary of said settling zone, whereby separation of the solids and liquids rapidly occurs in said settling zone.

2. A process as in claim 1 wherein said settling aid is a member of the group of organic polyelectrolytes.

3. A process as in claim 2 wherein said polyelectrolyte settling aid is an organic copolymer or acrylamide of molecular weight from about 2,000,000 to 3,000,000.

4. A process as in claim 1 wherein said settling aid is added in a proportion ranging from about 0.1 to 30 parts per million of said influent feed.

5. A process as in claim 1 wherein said influent feed of liquid slurry is introduced at a rate ranging from about 3 to 10 gallons per minute per square foot of cross-sectional filtering area within said zone of settling, said rate of influent feed being sufficient to induct degree of percolation within said zone of settling to increase the rate of additional agglomeration.

6. A process as in claim 1 wherein a portion of said dense underflow is recirculated and intermixed with the influent feed, such recirculation permitting a degree of control over the density of the dense underflow removed from the settling zone.

7. A process as in claim 1 wherein the average retention time of said influent feed in said settling zone is less than about five minutes.

8. A continuous process for treating liquids to remove substances therefrom in the form of solid particles and agglomerated solid particles, which comprises forming and maintaining a settling zone of concentrated slurry containing suspended solid particles and agglomerated solid particles of like nature to those to be formed and sep[sic] separated, mixing solids-containing liquid to be processed with a settling and agglomerating agent,

said mixing producing a liquid slurry containing freshly agglomerating solids, introducing said liquid slurry as an influent feed at a central position within said settling zone, arresting the motion of said influent feed and displacing the same outwardly through the concentrated slurry in said settling zone to effect additional agglomerations of the solid particles, whereby relatively large agglomerates of solid particles are formed which settle rapidly without additional agitation to form a dense underflow of agglomerates and entrained solid particles, the point of arresting said influent feed being close to said central point of introducton[sic] of the influent feed, controlling the depth of said settling zone by withdrawal of said dense underflow so that said settling zone of concentrated slurry is provided with a relatively stationary upper boundary, the rate of withdrawal of said dense underflow being such that said upper boundary of the settling zone is above the point of arresting the motion of the influent feed, and withdrawing clarified liquid from above said settling zone of concentrated slurry.

9. In an apparatus for rapidly and continuously separating finely divided and suspended solid materials from liquids at a predetermined and controlled rate, a settling vessel having top an[sic] bottom outlet means, inlet means including conduit means extending to a centralized position within said settling vessel, means for introducing a substantally[sic] vertical flow of influent feed of liquid containing freshly agglomerating solid materials to said centralized point of entry established by said conduit means, unitary substantially horizontal baffle means adjacent the point of entry established by said conduit means for arresting and altering the direction of motion of said influent feed whereby the influent feed is directed in a horizontally outward direction with respect to said centralized point of entry, means controlling the rate of discharge of solid materials through said bottom outlet means to control and thereby establish settling and sludge zones above and below said centralized

point of entry of influent feed, and means for withdrawing a clarified effluent through said top outlet.

10. Apparatus as in claim 9 wherein said means for arresting and altering the direction of flow of said influent feed comprises vertically adjustable baffle means positioned closely adjacent said point of entry for said influent feed and transverse to the direction of fluid flow.

11. Apparatus as in claim 9 wherein said inlet means includes a flared outlet on said conduit means for effecting a gradual reduction in the flow velocity of said influent feed.

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MICHAEL E. ROGERS, Primary Examiner

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210-46, 84, 95, 112, 207, 519

U.S. Patent Oct 25, 1977 Sheet 1 of 2 4,055,494

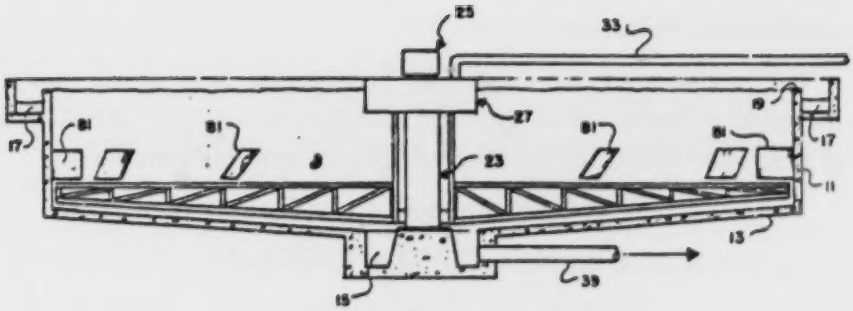

FIG. 1

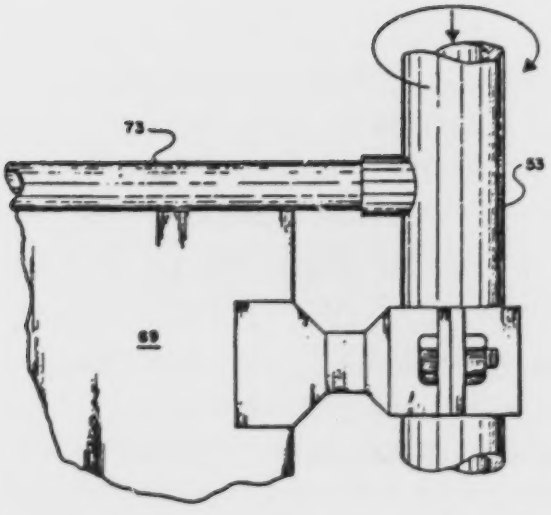

FIG. 3

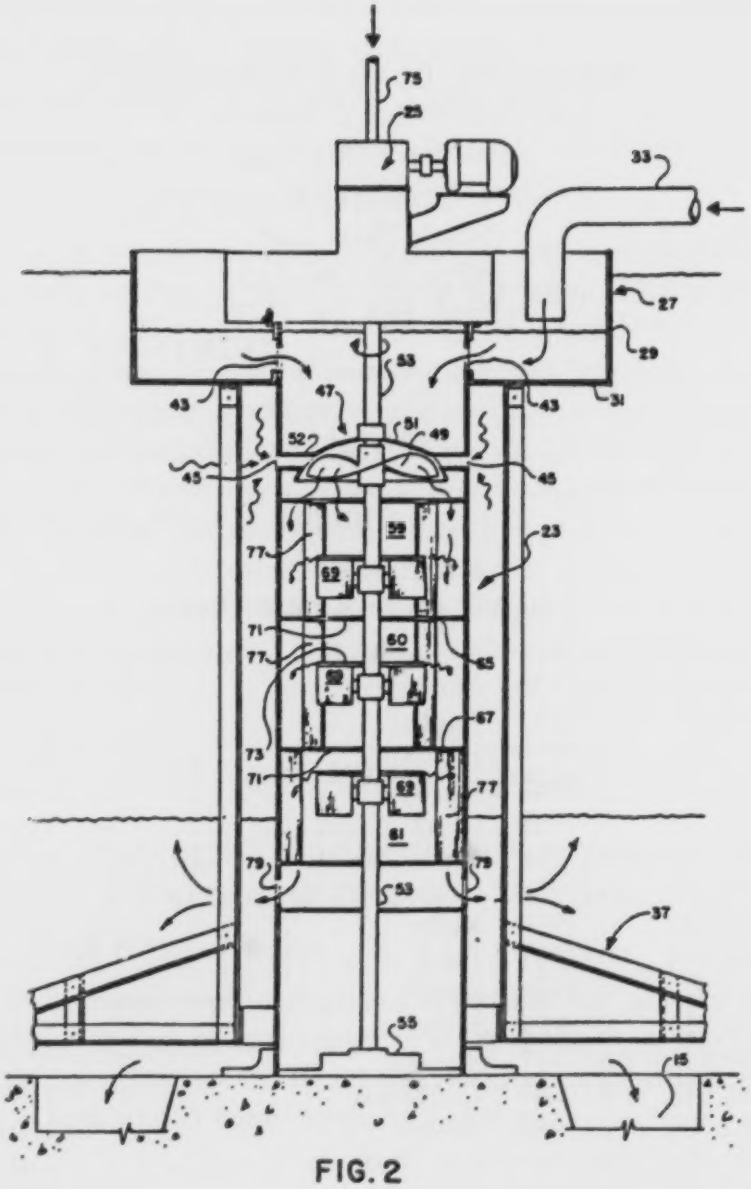
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FIG. 2

APPENDIX "B"

UNITED STATES PATENT 4,055,494
Emmett, Jr. Oct. 25, 1977

THICKENING DEVICE AND METHOD

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U.S. Cl. 210/49; 210/61; 210/84; 210/199; 210/208; 210/519
Field of Search ..... 210/49, 83, 84, 207, 210/208, 519, 520, 61, 199, 42 R

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ABSTRACT

A machine is disclosed for separating solids from feed liquor by gravity settling to form thickened subnatant. The machine includes a liquid-holding tank having an upstanding tubular column mounted therein for receiving the feed liquor. An inlet is formed in the upper portion of the column to admit clarified supernatant into the column for mixing with, and dilution of, the feed liquor. A plurality of subadjacent compartments include reagent introduction and mixing means to receive the feed liquor and to mix a chemical flocculating reagent thereinto. At the bottom of the column is an outlet to discharge the flocculated liquor directly into a pulp blanket stratum established within the tank.

21 Claims, 3 Drawing Figures

THICKENING DEVICE AND METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to gravitational separation by sedimentation and, more particularly, to ways and means for continuously separating suspended solid materials from a feed stream liquor by gravity settling.

2. State of the Art

Sedimentation devices which incorporate liquid-holding tanks are well known to separate suspended solids from streams of liquid, such as water and wastewater, by gravity settling. To hasten separation, it is well known to employ various chemical flocculating reagents. When added to the influent liquor, the reagents combine with the suspended solids to form rapidly settlable aggregates, called floc. Typically, the mixing of flocculating reagents with feed slurry is accomplished outside the sedimentation tank proper, say in a flowing pipeline or launder and, in the case of dilute suspensions (say, less than 0.1%), may be accompanied by a mechanical stirring of the feed liquid to provide contact opportunity and time for the resulting flocs to grow. In some cases where the feed solids concentration is high, say 20% to 30% by weight, it is of known benefit to dilute the feed slurry in order to improve flocculation and, thereby, sedimentation; in known machines, this is accomplished outside the sedimentation tank proper.

Sedimentation devices are termed "clarifiers" or "thickeners" depending upon whether they operate upon liquid streams having relatively low or high concentrations of suspended solids and/or whether the primary objective is a clear overflow or a dense, concentrated underflow (in some cases both conditions may be required of a thickener). As used herein, the term "sedimentation device" refers primarily to thickeners and similar continuously-operating gravity settling devices.

OBJECTS OF THE INVENTION

A primary object of the present invention is to provide an improved sedimentation machine for treating mineral slurries, industrial wastes and sewage, and the like, where the sedimentation device has the capacity to handle high flow rates of influent liquor per unit volume of the liquid-holding tank while still providing good clarity in the supernatant liquid. Slurries of finely divided solids which the sedimentation machine of the

invention is intended to treat include, for example, ore slurries, pulp and paper recausticizing slurries, flue gas scrubbing slurries, coal refuse slurries, and municipal and industrial wastewaters.

Another object of the present invention is to provide a thickening machine for the purposes described above which operates effectively without recycling or recirculating thickened solids.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other subjects and advantages of the present invention can be readily ascertained from the following detailed description and appended drawings, which are offered by way of example only and not in limitation of the invention, the scope of which is defined by the appended claims and equivalents. In the drawings:

FIG. 1 is a cross-sectional view of a machine in accordance with the present invention, parts of which are shown schematically;

FIG. 2 is a cross-sectional detail, enlarged for purposes of clarity, of a portion of the mechanism in FIG. 1; and

FIG. 3 is a cross-sectional view, again enlarged for purposes of clarity, of a detail of the mechanism shown in FIG. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The sedimentation machine in FIGS. 1 and 2 includes a liquid-holding tank which is typically circular in configuration and is defined by a marginal upstanding sidewall **11** and a bottom wall **13**, the latter which slopes downward toward a sump **15** formed centrally in the bottom wall of the tank. Mounted peripherally about the sidewall **11** is a launder **17** inclusive of an overflow weir wall **19** which defines the liquid level in the tank. Centrally disposed in the tank is an upstanding tubular column **23**. The tubular column can be either stationarily supported

from the tank floor as shown or can be suspended for rotation from a bridge or other trusswork which traverses the tank.

Further with regard to the embodiment shown in FIGS. 1 and 2, drive unit **25** of conventional construction is mounted atop the stationary center column **23**. Below the drive unit and supported therefrom is an annular feedwell **27** which concentrically surrounds the center column. The annular feedwell comprises a cylindrical baffle wall **29** and an annular bottom wall **31** which is in sealing engagement with the column **23**. Further, the annular feedwell **27** is coupled by conventional structural means, not shown, to the drive unit **25** to be driven thereby in rotation about the center column. A conduit **33** is mounted to convey a stream of feed liquor containing suspended solids into the feedwell.

As also shown in FIGS. 1 and 2, a raking mechanism **37** of conventional construction is mounted to be driven in rotation about the column **23** by the drive unit **25** and is arranged to rake thickened solids across the bottom or floor **13** of the tank. In the illustrated embodiment, the raking mechanism **37** should be understood to be fixedly connected to the feedwell **27** which, in turn, is connected to the drive unit **25** for rotation. Also in the illustrated embodiment, the raking mechanism **37** should be understood to be disposed to urge settled (thickened) solids towards the aforementioned sump **15** formed about the base of the column **23**. From the sump **15**, the thickened solids are pumped to discharge via an underflow conduit **39**.

Concomitant with the removal of thickened, settled solids via the sump **15**, clarified supernatant spills over the weir wall **19** and is carried to discharge via the launder **17**. This is, of course, a conventional arrangement well known in the sedimentation art.

With reference now particularly to FIG. 2, at least one port **43** is formed through the sidewall of the column **23** in liquid flow communication with the interior of the feedwell **27**. By means of this port **43**, a stream of feed liquor is fed into the interior of the column **23**. Thus, it can be understood that feedwell **27** differs

from the conventional in that it feeds feed liquor inwardly, not outwardly. It should also be understood that alternative means can be provided to introduce liquor into the tubular column; for example, the feed liquor could be introduced into the tubular column through a central opening in an annular drive gear which operates the raking mechanism.

Below the feedwell **27** there is formed at least one port **45** through the sidewall of the tubular column **23**. Port **45** is called the dilution port because it is in liquid flow communication with a clarified liquid zone or stratum in the liquid-holding tank, which stratum contains a relatively low percentage of suspended solids. The clarified liquid (supernatant) conveyed through the dilution port **45** serves to dilute the above-mentioned feed stream. In practice, a pump or impeller means **47** is mounted within the column **23** to draw a stream of the dilution liquid through the port **45** and then to impel the liquid downward for mixing with the feed stream. The illustrated pump means **47** includes an impeller **49** mounted within a bell-like housing **51** and coupled to a drive shaft **53** for rotation therewith. The upper end of the drive shaft **53** is coupled to the aforementioned drive unit **25** or to an auxiliary rotary drive; the lower end of the drive shaft **53** is mounted in a bearing means **55**, but other support means could be provided. The interior of the bell-like housing **51** is in liquid flow communication with dilution port **45** via a pipe member **52**, thus providing an internal recycle. The term internal recycle is intended to convey the concept that dilution of the feed liquor with clarified supernatant is accomplished within the thickening machine itself and without removing supernatant therefrom. The dimensions of the bell-like housing **51** are such that the feed stream liquor can flow downward around the periphery of the housing and thus into the column **23** below the pumping means **47** for mixing with the dilution liquid. As an alternative, a single axial flow impeller having a diameter less than that of the column **23** can be employed to provide the

necessary downward pumping, thus eliminating the need for the housing **51**.

It should be appreciated that the pumping means **47** is normally necessary because the hydrostatic head imposed by the tank contents plus the hydraulic head loss due to the flowing feed liquor through the column **23** can result in the liquid level within the column exceeding the liquid level outside the column. But for the pumping means in such instances, the excess head in the column would force liquid out of the dilution port **45**. In practice, the dilution ratio is selectively adjustable by either varying the pumping rate directly or by changing the area of the dilution port by an adjustable gate means, not shown. One typical example of dilution occurs in the processing of uranium-bearing minerals where slurries of such minerals having solids concentration above about 20% are normally diluted down to about 10% in order to provide improved flocculation and settling. On the other hand, in some applications where the feed solids concentration is initially low, good flocculation can be achieved without dilution and, hence, the dilution step can be omitted together with the aforedescribed structure to accomplish the same.

Formed within the tubular column **23** below the dilution streat entry ports **45** are a plurality of subadjacent flocculating-mixing compartments or stages **59-61** which sequentially receive the diluted feed liquor. Since the three illustrated stages are generally the same, only stage **60** will now be described in detail. The roof and floor of the stage **60** are defined by annular baffle plates **65** and **67**, respectively, which are fixed horizontally to the interior wall of the tubular column. The center openings **71** in the annular baffle plates **65** and **67** are of sufficient size to accommodate the aforementioned drive shaft **53** as well as to permit the flow of diluted feed liquor into and then out of the flocculating-mixing stage **60**. Although other means could be provided to convey the diluted feed liquor sequentially to and

from the flocculating-mixing stages, the illustrated embodiment is preferred because of its structural simplicity.

Referring now to FIGS. 2 and 3, each of the flocculating-mixing stages **59-61** include mixing means to stir the liquid therein to provide rapid blending of flocculant solution and feed slurry. In the illustrated embodiment, the mixing means is a set of radially-extending mixing blades **69** fixed to the drive shaft **53** for rotation therewith. Also mounted within each of the flocculating-mixing stages is means to introduce a chemical flocculating reagent; in the illustrated embodiment, the shaft **53** is shown as being hollow and it carries the flocculating reagent in liquid form for introduction to the respective flocculating-mixing stages **59-61** via radially-extending reagent-dispersing pipes **73.** In the embodiment in FIG. 2, the reagent is supplied through the shaft **53** from a reservoir, not shown, via a supply conduit **75.** In operation, the reagent liquid is discharged through the dispersing pipes **73** upon rotation of the mixing blades **69.** The presence of the reagent and the blending action effectuated by the mixing blades **69** serves to cause the solids in suspension in feed liquor to aggregate and form flocs. Typical dosages when polymer-type flocculants are used are about 10-30 ppm.

In the preferred embodiment and as shown in FIG. 2, a plurality of thin baffle plates **77** are vertically mounted at spaced-apart positions within at least some of the flocculating-mixing stages. The purpose of the baffles **77** is to assist in the flocculating action and to prevent disruptive vortexes or swirls from being established in the flocculating-mixing stages. Typically, four baffles are provided per flocculating-mixing stage, but this is a matter of choice.

In summary to this point, the interior of the tubular column **23** can be understood to comprise three zones; a zone for receiving the stream of feed liquor, a subadjacent dilution zone for receiving clarified liquid for diluting the stream of feed liquor, and a zone comprising a plurality of subadjacent flocculating-

mixing stages in which downwardly flowing diluted feed liquor is mechanically mixed with a chemical flocculating reagent. The number of flocculating stages employed is dependent upon the feed rate and flocculation time required by a particular slurry. In some instances, the flocculating-mixing stages need not be immediately adjacent one another, but can be separated by a compartment which does not contain a set of mixing blades.

With reference again to FIG. 2, at least one outlet port **79** is formed through the sidewall of the column **23** at or below the lowermost flocculating-mixing stage. Through this outlet port, the diluted and flocculated feed liquor is discharged into the thickening tank proper and, more particularly, said port is positioned so that the liquor is discharged therefrom directly into the pulp blanket within the liquid body held in the thickening tank. The term pulp blanket herein refers to a stratum of thickened pulp which extends from the bottom of the thickening tank to some variable level below the tank surface; some workers in this art would also term this the sludge compaction zone. In typical situations, the interface between the pulp blanket and the clarified liquid stratum in the tank is remarkably well defined and can be readily determined by means of conventional sludge level detectors, say of the ultrasonic type. At this juncture it should be appreciated that conventional practice in this art suggests that the feed liquor should be introduced high in the clarified liquid stratum, not into the pulp blanket where the influx might disturb the thickening process; in other words, the introduction of feed liquor into the pulp blanket eliminates the so-called free-settling stratum which typically is found in thickening devices. Although it is within the scope of this invention to introduce the feed liquor into the thickening tank proper at a location immediately above the pulp blanket, it is much preferred to make such introduction directly into the pulp blanket as discussed above.

Referring again to the liquid-holding tank shown in FIG. 1., the tank preferably includes a plurality of inclined plate

members **81** mounted at generally regular intervals peripherally along the sidewall **11** of the thickening tank at least partially within the normal stratum of the sludge blanket. More particularly, the plate members **81** are mounted to extend upward at an angle of about 50° to about 60° from horizontal and, preferably, at an angle of 55°. The inclined plates can be mounted at spaced-apart intervals as shown or can be placed more closely together in overlapping relationship. The purpose of the inclined plate members **81** is to provide stabilization of the level of the sludge blanket stratum without the necessity of precise control of flocculant dosage or underflow pumping rates. With the aforedescribed discharge of diluted and flocculated liquor directly into the sludge blanket, the level of the sludge blanket becomes very sensitive to changes in feed rate, dilution ratio, and degree of flocculation. When such conditions suddenly change, the sludge blanket is apt to either rise toward the surface of the liquid-holding tank or to drop below the outlet port **79**, neither which action is desirable. However, when the aforementioned inclined plates **81** are utilized, the sludge blanket level remains remarkably stable over a wide range of feed rates without requiring continuous control of the flocculant dosage or underflow pumping rate. The absence of substantial fluctuations in the level of the sludge blanket seems to be due to the increase in physical settling area provided by the inclined plates. In practice, the sludge blanket level has been found to fluctuate only two to three inches when the inclined plates **81** are utilized whereas, without the inclined plates, the level of the sludge blanket fluctuated the full depth of the sidewall **11** of the liquid-holding tank.

In the FIG. 1 embodiment, the inclined plates **81** are mounted such that the arms of the raking mechanism **37** pass beneath the bottom edges of the inclined plates. This positioning of the inclined plates **81** is believed to provide an "unloading" action according to which the raking arms remove accumulations of

sludge from the areas between the inclined plates. The result is increased underflow density.

In one test of the aforedescribed sedimentation machine incorporating the inclined plates **81** versus the machine without the plates, the underflow density in terms of percent weight solids doubled from 12% to 24%. In that test, the inclined plates were constructed so as to increase the settling surface area in the tank by 120%; the phrase "settling surface area" in this context means the projected area of the inclined plates onto a horizontal plane and is compared to the horizontal expanse of the tank floor. With the addition of the inclined plates, the capability of the tank to handle influent liquor per unit of tank volume was consequently increased by about 270%.

In comparison to a conventional thickening device, pilot tests indicate that the aforedescribed sedimentation machine should provide superior results. For example, a typical thickener for coal refuse can be loaded at only about 0.05 to 0.1 tons per day per square foot of thickener floor area; tests on the aforedescribed machine indicated satisfactory thickening with loadings from 0.8 to 1.0 tons per day per square foot of thickener area. This is with typical underflow concentrations of 30-40% solids by weight and clarified effluents containing 100-300 ppm of suspended solids.

As an alternative embodiment, not shown, a second set of inclined plates can be mounted at generally regular intervals peripherally about the sidewall **11** of the thickening tank above the aforedescribed set of inclined plates **81**; in this alternative embodiment, the second set of plates would be mounted above the level of the pulp blanket and would have the purpose and effect of settling out discrete particles or flocs which escape upward from the pulp blanket zone.

As another alternative embodiment, the tubular column **23** could be mounted for rotation within the liquid-holding tank, instead of being stationarily mounted as hereinbefore described.

I claim:

1. A machine for continuously separating suspended solids from a feed stream liquor by gravity settling comprising:

a. a liquid-holding tank for containing a body of liquid in generally quiescent condition;

b. an upstanding tubular column mounted within said liquid-holding tank;

c. means mounted at the upper end of said tubular column to convey a stream of feed liquor into the interior of said tubular column;

d. flocculating-mixing compartments formed within said tubular column, one below another, to sequentially receive the feed liquor;

e. mixing means mounted within each of said flocculating-mixing compartments to blend the liquid therein;

f. reagent introduction means mounted within each of said flocculating-mixing compartments to disperse a chemical flocculating reagent into the compartment for enchancing the flocculation of suspended solids within the feed liquor;

g. discharge means in liquid-flow communication with the lowermost one of said flocculating-mixing compartments and with the interior of said liquid-holding tank for discharging the flocculated feed liquor, into a pulp blanket stratum at the bottom of said liquid-holding tank;

h. raking means including rake arms mounted within said liquid-holding tank to urge solids settled in the pulp blanket stratum to underflow discharge; and

i. overflow means mounted on said liquid-holding tank to remove clarified supernatant therefrom.

2. A machine according to claim 1 further including dilution means mounted in communication with the interior of said tubular column to admit clarified liquid into said tubular column from a stratum of supernatant liquid held within said tank for addition to the feed stream liquor.

3. A machine according to claim 2 further including impeller means mounted within said tubular column in communication with said dilution means to draw the clarified liquid into said column and to impel the same downward for mixing with the feed stream liquor.

4. A machine according to claim 1 further including vertically-extending plate members mounted at intervals peripherally along the sidewall of said liquid-holding tank immediately above the bottom of said tank.

5. A machine according to claim 4 wherein said plate members are mounted to extend upward at an angle of from about 50° to about 60° from horizontal.

6. A machine according to claim 4 wherein said plate members are mounted to extend upward at an angle of 55° from horizontal.

7. A machine according to claim 4 wherein said plate members are mounted so that the rake arms pass beneath their bottom edges.

8. A machine according to claim 4 wherein said plate members are all mounted at substantially the same elevation within said liquid-holding tank to comprise a first set.

9. A machine according to claim 8 further including a second set of vertically-extending plate members mounted at intervals peripherally along the sidewall of said liquid-holding tank to extend above the level of the pulp blanket stratum.

10. A machine according to claim 1 wherein said tubular column is stationarily mounted within said liquid-holding tank.

11. A machine according to claim 1 wherein said tubular column is mounted for rotation within said liquid-holding tank.

12. A machine according to claim 1 wherein said means mounted at the upper end of the tubular column comprises an annular feedwell to receive a stream of feed liquor and means in

liquid-flow communication between the interior of said feedwell and tubular column to convey feed liquor into said tubular column.

13. A machine according to claim 12 wherein said annular feedwell is structurally connected to said raking mechanism to rotate therewith about the tubular column.

14. A machine according to claim 2 wherein said dilution means includes a pump means mounted within said tubular column to draw the clarified supernatant liquid into said column and to impel that liquid downward within said tubular column for mixing with, and dilution of, said feed liquor.

15. A machine according to claim 14 further including a drive shaft which is mounted to extend downward through said tubular column and which is coupled to said pump means to drive the same.

16. A machine according to claim 1 wherein at least one of said flocculating-mixing compartments is defined, at its respective upper and lower ends, by annular baffle plates which are fixed horizontally to the interior wall of the tubular column and wherein the center openings in said annular baffle plates are of sufficient size to permit the flow of diluted feed liquor into and then out of the flocculating-mixing compartment.

17. A machine according to claim 1 wherein said mixing means comprises a set of radially-extending mixing blades and a drive shaft which is mounted to extend downward through said tubular column to rotatably drive said mixing blades.

18. A machine according to claim 17 wherein said drive shaft is hollow and is connected to carry chemical flocculating reagent to said flocculating-mixing compartments.

19. A machine according to claim 18 wherein said reagent introduction means comprises radially extending pipe members

connected to said hollow drive shaft to rotate therewith to disperse chemical flocculent reagent therefrom into the respective flocculating-mixing compartments.

20. A machine according to claim 1 further including thin baffle plates vertically mounted within at least one of said flocculating-mixing compartments.

21. An improved process for continuously separating suspended solids from a feed stream liquor by gravity settling comprising the following steps:

a. introducing feed stream liquor into a first zone in liquid flow communication with a liquid-holding tank which holds a body of liquid in generally quiescent condition;

b. then diluting the feed stream liquor with clarified liquid from a stratum of supernatant liquid held within the liquid-holding tank;

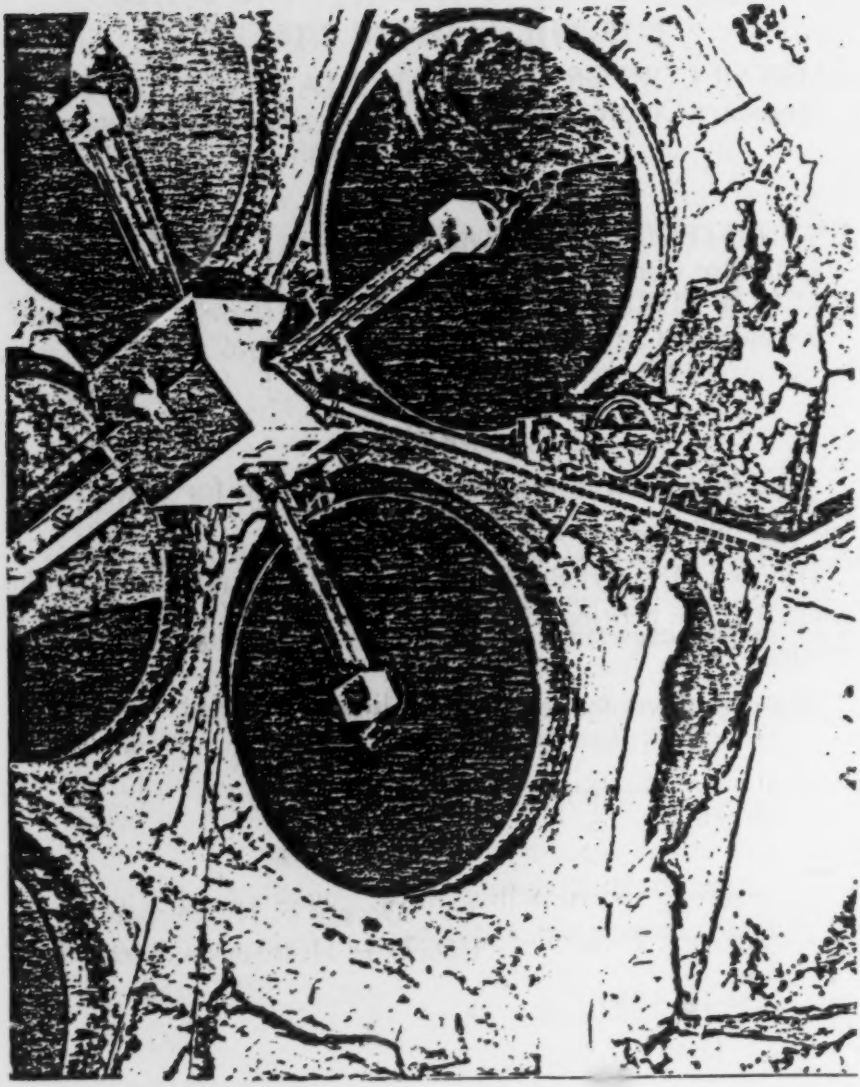
c. then passing the diluted feed liquor through a plurality of subadjacent stages and, in each of said stages, dispersing chemical flocculating reagent into the diluted feed liquor and mechanically mixing the liquor and reagent to promote the aggregation of suspended particles into flocs;

d. then discharging the flocculted[sic] and diluted feed stream directly into a pulp blanket stratum formed at bottom of the liquid-holding tank proper;

e. removing settled pulp from the liquid-holding tank; and

f. removing a clarified supernatant from the liquid-holding tank.

* * * * *



Appendix "C": 17′ Enviro-Clear Thickener vs. 100′ Conventional Thickeners
(See Px-14; Testimony of J. Muldowney, Tr. at 96-97.)

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

AMSTAR CORPORATION, A
Delaware Corproation,[sic]
Appellant,

v.

ENVIROTECH CORPORATION, A
Delaware Corporation; and
ENERGY FUELS NUCLEAR, INC.,
a Colorado Corporation,
Appellees.

No. 83-1090

ORDER

A petition for rehearing and a suggestion for rehearing in banc having been filed in this case,

UPON CONSIDERATION THEREOF, it is Ordered by the court that the petition for rehearing be, and the same is hereby, Denied.

The suggestion for rehearing in banc is declined.

FOR THE COURT

/s/ George E. Hutchinson
George E. Hutchinson, *Clerk*

June 12, 1984
Date

cc: Gerald W. Griffin
V. Bryan Medlock, Jr.

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

AMSTAR CORPORATION, a Delaware Corporation,
Appellant,

v.

ENVIROTECH CORPORATION, a Delaware Corporation; and Energy Fuels Nuclear, Inc., a Colorado Corporation,
Appellee.

No. 83-1090

ORDER

A petition for rehearing having been filed in this case,

UPON CONSIDERATION THEREOF, it is Ordered by the court that the petition for rehearing is granted only to the extent of certain modifications to the opinion; otherwise the petition is Denied.

FOR THE COURT:

/s/ George E. Hutchinson
George E. Hutchinson, *Clerk*

April 16, 1984
Date

cc: Gerald W. Griffin
V. Bryan Medlock, Jr.

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

April 16, 1984

ERRATUM

Appeal No. 83-1090

Amstar Corporation v. *Envirotech Corporation and Energy Fuels Nuclear, Inc.*

Decided March 27, 1984

Please make the following changes:

Page 4, fn. 3, line 6 —insert "specifically" after "costs".

Page 12, fn. 5, line 7 —delete "requested or".

line 8 —add "Presumably, the district court will consider on remand Amstar's requests for such findings and for costs, treble damages, and attorney fees".

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

AMSTAR CORPORATION
Appellant,

vs.

ENVIROTECH CORPORATION and
ENERGY FUELS NUCLEAR, INC.
Appellees.

No. 83-1090
C79-0023J

JUDGMENT

ON APPEAL from the US District Court of Utah

This CAUSE having been heard and considered, it is ORDERED and ADJUDGED: REVERSED AND REMANDED, for consideration of an injunction against further infringement by Envirotech and for an accounting of damages "adequate to compensate" Amstar for infringement. *Costs*: Envirotech shall pay to Amstar an amount equating to double Amstar's costs on this appeal.

DATED March 27, 1984
Petition for Rehearing allowed only to the extent of modifications to the opinion,
April 16, 1984.
Above rehearing filed by Appellant.

ENTERED BY ORDER OF THE COURT

GEORGE E. HUTCHINSON, CLERK

/s/ George G. Hutchinson
Clerk

ISSUED AS A MANDATE: June 20, 1984
COSTS: Against. Appellees
Printing $1090.00
TOTAL $1090.00
As indicated in the attached opinion Envirotech shall pay to Amstar an amount equating to double the above costs: $2,180.00.

Appellees' Petition for Rehearing, Denied, June 12, 1984.
Appellees' Suggestion for Rehearing In Banc, Declined, June 12, 1984.
Appellant's Motion for Award of Attorney's Fees and Expenses, Denied, May 2, 1984.

IN THE
UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF UTAH

CENTRAL DIVISION

AMSTAR CORPORATION a Delaware corporation, *Plaintiff,* vs. ENVIROTECH CORPORATION, a Delaware corporation and ENERGY FUELS NUCLEAR, INC., a Colorado corporation, *Defendants.*	Civil No. C 79-0023J JUDGMENT

This action came on for trial before the Court, Bruce S. Jenkins, District Judge, presiding, and the issues having been duly tried and a decision having been duly rendered,

IT IS ORDERED and ADJUDGED:

That the plaintiff Amstar take nothing, that the action be dismissed on the merits, and that the claims of the defendants Envirotech and Energy Fuels Nuclear, Inc. be dismissed on the merits, and that each party shall bear its own costs of action.

DATED this 3rd day of May, 1983.

BY THE COURT:

/s/ Bruce S. Jenkins
BRUCE S. JENKINS
United States District Judge

EXCERPTS FROM PLAINTIFF-APPELLANT'S APPEAL BRIEF TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

. . . .

[15]

Envirotech made, used and sold several types of clarifier-thickeners. Of course, each type must be considered separately in analyzing infringement. Envirotech's apparatus may be classified as follows:

(a) 3 "pilot plants" made and used by Envirotech;

(b) one Envirotech thickener made for and sold to Eagle Coal & Dock and used by that company;

(c) the Eagle Coal & Dock thickener as allegedly and subsequently modified and used;

(d) 7 Envirotech thickeners made for and sold to Energy Fuels Nuclear (these are similar to the pilot plants); and

(e) the Energy Fuels Nuclear thickeners as subsequently modified and used by that company after suit was filed.

All other thickeners made and sold by Envirotech are similar to one of the above types.

. . . .

[35]

In particular, the lower Court found that Envirotech modified its apparatus to eliminate the horizontal baffle plate positioned near the bottom of the inlet or feedwell, an element of Eis' apparatus Claim 9. In fact, Envirotech replaced the horizontal plate with impeller blades and a rotating disc — a different name for an equivalent device to deflect the flow radially outward into the settling zone.

. . . .

[43]

The initial Envirotech apparatus clearly had all elements of the Eis patent claims, including a horizontal baffle plate at the bottom of the feedwell or inlet pipe to direct the flow radially outward into the settling zone (A 241, 273; E 95-97, E 102-113, E 121-126, E 131-138, E 157). There is no question that a baffle plate was used in the pilot plants, the apparatus sold and delivered to Eagle Coal & Dock and the apparatus designed for Energy Fuels Nuclear. The lower Court found that the original Envirotech devices "use a modified baffle plate design at the base of the feedwell" (A 73).

The District Court erroneously found, however, that Envirotech avoided infringement by replacing the horizontal plate near the bottom of the feedwell with the impeller blades and rotating disc in supposed "later designs" (A 72-A 73). The disc and blades function, as does a horizontal plate, to deflect the flocculated feed into a substantially radially outward dispersion pattern within the settling zone to produce additional agglomeration and concentration of solids (A 161-A 168, A 215-A 216, A 248-A 249, A 307-A 308). The impeller blades and *[44]* rotating disc perform the same work and achieve the same result as Eis' horizontal plate. This was demonstrated at trial by Dr. Spottiswood (PX 30). The modified apparatus infringes Claim 9 under the doctrine of equivalents, if not literally.

Although apparatus Claim 9 recites the baffle means, process Claims 1 and 8 include no such recitation and are not dependent upon that means. Envirotech's allegedly modified apparatus as used at Energy Fuels Nuclear and Eagle Coal & Dock clearly employ the process of Claims 1 and 8.

Infringement was shown by testimony of Amstar's expert witness Dr. Spottiswood, Envirotech's research executives, Dr. Dahlstrom and Silverblatt, and Envirotech's mixing consultant

Wilcox (A 117-A 131, A 156-A 178, A 195-A 196). Dr. Spottiswood concluded:

> "Q. You've now compared claims 1, 8 and 9 of the Eis patent to three different structures of Envirotech, one labeled pilot plant, one labeled Eagle Coal and Dock and one labeled Energy Fuels Nuclear. In comparing each of these claims to each of those units, have you found any element of those three principal claims of the Eis patent which does not appear in the Envirotech units?
>
> "A. No, I have not." (A 130-A 131).

Interestingly, the testimony of Dahlstrom, Silverblatt and Wilcox all was directly contrary to that given by Envirotech's expert witness Emmett, who is Silverblatt's subordinate (see e.g., A 258-A 260, A 279-A 280, A 290). Emmett testified in conclusion: *[45]*

> "Q. So, now we're in the situation, are we not, Mr. Emmett, that all of the documents and deposition drawings by your vice-president, the reports of your consultant say the flow is going sideways, and the only thing we have that disagrees with them is your oral testimony?
>
> A. That's right. I was the only one that measured it." (A 287)

Nonetheless, the District Court relied only upon Emmett's testimony, and ignored Spottiswood's, Silverblatt's, Wilcox's and Dahlstrom's testimony.

In view of the clearly erroneous findings of fact, the District Court erred in failing to conclude that Envirotech's apparatus and process infringe the claims of the valid Eis patent both literally and under the doctrine of equivalents.

. . . .

EXCERPTS FROM COMBINED PETITION FOR REHEARING AND SUGGESTION FOR REHEARING IN BANC OF APPELLEES ENVIROTECH CORPORATION AND ENERGY FUELS NUCLEAR, INC. TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

[1]

ISSUES

1. Has this Court complied with Rule 52(a) in finding infringement of U.S. Patent No. 3,523,889 ('889 patent), where the Trial Court expressly found that an element of the claims, the arresting of influent feed, is *not* present either literally or as an equivalent in the accused apparatus and process, and where this Court neither found that the Trial Court's findings are clearly erroneous nor even acknowledged their existence?

2. Has this Court complied with Rule 52(a) where, after concluding that the Trial Court had erroneously interpreted the law, it did not remand the case for application of the correct law to the facts in dispute?

. . . .

[2]

STATEMENT OF THE CASE

On March 27, 1984, this Court rendered its decision, reversing the Trial Court's noninfringement decision by holding that Envirotech had infringed Claims 1, 8 and 9 of the '889 patent (the only claims at issue), mandating an accounting of damages, and assessing double costs against Envirotech.

SUMMARY OF THE ARGUMENT

The rationale for this Court's decision as to infringement was that the Trial Court, under a misinterpretation of the Law, failed to compare the accused equipment with the claims and failed to find any element of the claims missing from the accused

equipment. (Op., pp. 9-10). The Trial Court was therefore reversed as a matter of law. (Op., pp. 9-10). *In fact, the Trial Court did make express findings of fact that an element in the claims and its equivalent is missing from the accused equipment.* With no discussion of the record, this Court *[3]* substituted its own findings of fact for these findings by the Trial Court, without holding them to be clearly erroneous, all in contravention of Rule 52(a), Fed.R.Civ.P. The findings are *not* clearly erroneous, and should have been affirmed. Alternatively, if the Trial Court did misinterpret the law, the case should have been remanded for additional findings in accordance with a proper interpretation of the law.

. . . .

ARGUMENT

I. THIS COURT DISREGARDED THE TRIAL COURT'S FACTUAL FINDING OF NONINFRINGEMENT DUE TO AN OMITTED ELEMENT OF THE CLAIMS.

This Court's March 27, 1984 Opinion held that the Trial Court erred by not comparing Envirotech's equipment to the claims. This Court went on to find that the Envirotech equipment literally infringes the claims. In independently finding infringement, the Court ignored Envirotech's evidence that its equipment in use does *not* have the step of "arresting of the motion of the influent feed" required by claims 1 and 8 of the '889 patent and that its commercial machines do *not* have a baffle plate as required by claim 9. Further, the Trial Court's finding in Envirotech's favor on those issues was not found to be clearly erroneous, and, in fact, was not even mentioned in this Court's *[4]* Opinion. The failure to address the Trial Court's finding, and the evidence in support thereof, contravened Rule 52(a) of the Federal Rules of Civil Procedure.

A. The Trial Court Found No Literal Infringement of the Claims of the '889 Patent.

Process claims 1 and 8 of the '889 patent each require the step of "arresting the motion of the influent feed and displacing the same outwardly" into the settling zone to cause additional agglomeration of the solid particles. Apparatus claim 9 requires a "substantially horizontal baffle means adjacent to point of entry. . . for arresting and altering the direction of motion of the influent feed whereby the feed is directed in a horizontal outward direction. . . ."[1] (E7)

Significantly, the Trial Court made an express and clear finding of fact (A72-73, including footnote 55) that the Envirotech devices do *not* contain a baffle plate as required by the claims. In particular, the District Court found:

> "Other differences, such as the absence of . . . a specially positioned flat baffle plate stationed a short distance below the feedwell,[55] . . . point to a materially different combination . . ." (A72-73).

[5] This finding, and footnote 55 of the Trial Court's Opinion which explains the finding, were deleted from this Court's quotation of the Trial Court at page 9 of this Court's Opinion. In footnote 55, the Trial Court stated:

> "[55]While it is true that several Envirotech documents and drawings refer to use of a flat plate to disperse the feed, see e.g., PX-85C, PX-53B, at 3; PX-58, at 1079; PX-88, at 1 & Fig. 1; PX-89, at Fig. 1; PX-90A, at 2(?), or use a modified baffle plate design at the base of the feedwell, see e.g., PX-93A; PX-93B, the feedwell design for the EFN facility was modified to be a square center well without a bottom.

---

[1] For the sake of simplicity, the missing apparatus element, the baffle plate, and the missing process step of arresting the influent feed are hereinafter collectively referred to simply as the "arresting" element. The baffle plate structure and the step of arresting the motion of the influent feed were added to the claims to distinguish them from the prior art. See the pertinent portion of the File Wrapper of the '889 patent found at E26-28.

> See Minutes of Meeting, Feb. 28, 1979, PX-102; Memorandum, C. Garrett to D. Wells, Mar. 1, 1979, PX-103; Diagram of Hi-Capacity Thickener for EFN, PX-107; Instruction Manual, PX-108. Envirotech's later designs do not include flat baffle plates or flared feedwells. See Diagrams, PX-114-120. The Eagle Coal and Dock Co. feedwell was similarly modified following discussion with Enviro-Clear personnel. See Deposition of C. Silverblatt, Tr. at 376–380; compare PX-123 with PX-121. *Consequently the equipment in question in this lawsuit does not use a flat baffle plate as described by the Eis claims.* Testimony of R. Emmett, Tr. at 864-875.
>
> . . . .
>
> (emphasis supplied, A73).

Because the Envirotech devices in question do not use a baffle plate, the "arresting" step in the method claims is also absent, because the baffle plate was the "arresting" element in the method claims, as admitted by Amstar (Amstar Brief, p. 19). It is thus clear that the Trial Court found *omission* of any "arresting" element in the accused equipment. Regardless of its interpretation of the law, there can be no dispute that this [6] finding was made by the Trial Court and precludes literal infringement.

B. This Court Failed to Address the Trial Court's Finding of No Literal Infringement.

This Court characterized the issue of infringement as "unchallenged", and made its own finding of literal infringement based solely on Amstar's evidence, the claim charts. (Op., pp. 13-14).[2] To the contrary, footnote 55 clearly establishes that literal infringement was not only disputed, but decided against Amstar upon consideration of substantial evidence.

---

[2] The Amstar claim charts are not accurate depictions, as admitted by Amstar's expert, Dr. Spottiswood (Tr. 305), and as explained by Envirotech's expert, Emmett (Tr. 864-875), especially with respect to the arresting element.

Apparently, in an effort to support its silent disregard of the Trial Court finding of no literal infringement, this Court erroneously states that the Envirotech brief does not even make one reference to a step of process claims 1 and 8, or to any element of product claim 9 asserted to be absent. (Op., p. 15). To the contrary, Envirotech refers the Court to several passages in its brief which fully describe the absence of the "arresting" element. (Appellees' Brief, pp. 10, 11, 13, 17 and [7] 18.)[3] In fact, even Amstar's brief discusses the existence of conflicting testimony among the witnesses and in the exhibits as to whether the "arresting" element of the claim was found in the Envirotech equipment. (Amstar's Brief, pp. 44-45).

The question of literal infringement was clearly a disputed question of fact on which the Trial Court made an express fact finding. Yet, this Court disregarded the Trial Court's finding and substituted its own findings without even pointing out if or why the Trial Court's findings were clearly erroneous. As explained in Subsection D below, this substitution violated Rule 52(a).

C. This Court Failed to Address the Trial Court's Finding of No Infringement by Equivalence.

The Court not only made an independent finding of literal infringement, but also stated:

> "The record further illustrates that the modifications assertedly made by Envirotech, whenever they have been made, are either irrelevant or fail to escape infringement. The accused products, including those modified, are the same, they perform the same function in the same way, and

---

[3] The Court perhaps was misled by the erroneous statements in Amstar's reply brief that Envirotech has conceded "use of all elements of claims 1–10" and that Envirotech's brief "does not rely on the alleged absence of a flat baffle plate". (Amstar Reply Brief, pp. 1, 4). These false statements of the Plaintiff clearly did not aid the Court in its effort to reach a just result.

> they achieve, as the District Court found, the same result as the claimed inventions." (Op., p. 14).

[*8*] Although it was not explicit in quoted language (because no part of the record is cited), it is presumed that the language was intended to apply, *inter alia*, to the "arresting" element. Amstar's brief contains substantial argument that the "arresting" element was present in the Envirotech equipment on the basis of the doctrine of equivalents. (Amstar's Brief, p. 35).

This Court's finding of equivalence directly contradicts the Trial Court's finding in the second paragraph of footnote 55:

> Even where a feedwell design might have some form of bottom, flange, or base plate on the impeller shaft, the *function* of the base plate is *arguably dissimilar* to the Eis *baffle*. See generally Testimony of R. Emmett, Tr. at 728-749. The *effects* of the mixing chambers, impellers and baffles *cannot be ignored* in making findings as to infringement." Cf. Tr. at 1101. (emphasis supplied, A73).

In finding the function of the base plate "arguably different" from the claimed baffle arresting element, and focusing on the "effects" of the alleged equivalents of the baffle, the Trial Court rejected Amstar's argument that the rotating plate was the equivalent of the claimed arresting means. The Trial Court's finding of no equivalence was supported by substantial evidence (Tr. 743-46, 880, 892-94, 1085-89), and Amstar acknowledged that the testimony was conflicting in extensive discussion (Amstar's Brief, pp. 43-44).

Again, in disregard of the Trial Court's express finding of no equivalence, this Court stated: [*9*]

> ". . . nor could substitution of a rotating disc for the baffle of claim 9 escape infringement, the two being equivalent and the substitution bearing no relation to claims 1 and 8." (Op., p. 11).

This Court's finding of equivalence, in direct contradiction to the Trial Court's finding and the evidence supporting it, is not based upon *any* cited evidence or rationale. The issue of an

equivalent element to the "arresting" element was a disputed fact issue decided by the Trial Court, yet it was decided independently by this Court without pointing to the evidence which shows the Trial Court's finding to be clearly erroneous. As will now be explained, this summary substitution of fact findings violated Rule 52(a).

D. This Court's Disregard of the Trial Court's Findings Contravenes Rule 52(a) Fed.R.Civ.P.

As established above, the Trial Court made express findings of fact concerning the absence of an arresting element, and any equivalent thereof, in footnote 55. This Court totally ignored those findings, and instead substituted its own view of the facts to hold that the claims were infringed.

Rule 52(a) provides in part:

> . . . Findings of fact shall not be set aside unless clearly erroneous, and due regard shall be given to the opportunity of the trial court to judge of the credibility of witnesses. . . ."

The Supreme Court applied Rule 52(a) in *Inwood Laboratories, Inc.* v. *Ives Laboratories, Inc.*, 456 U.S. 844 (1982). In *Inwood*, the appellate court, as did this Court, independently decided facts contrary to the Trial Court's [*10*] findings without labelling them clearly erroneous. The Supreme Court held this to be clear error, and contrary to Rule 52(a), because "[D]etermining the weight and credibility of the evidence is the special province of the trier of fact." (at 856). The Supreme Court further held, "The appellate court was not entitled to simply disregard the District Court's finding of functionality." (at 858).

As this Court recognized, this action was tried over an 8 day period. The trial transcript ran over 1,150 pages. Some 300 exhibits totalled over 4,000 pages of technical diagrams, photos and articles. (Op., p. 2). The Trial Court was presented with demonstrative evidence, attended and observed on-site

demonstrations where the fluid flow could be observed in person, and was able to view and judge the demeanor and credibility of the witnesses who presented the evidence at trial. (Tr. 703-713). Rule 52(a) takes into account the inability of this Court to put itself in the same position as the Trial Court. Under Rule 52(a), and the *Inwood* decision which applies it, it is improper for this Court to make its own findings, or to substitute its findings for those of the Trial Court, without finding the Trial Court's findings to be clearly erroneous.

E. Misinterpretation of the Law Requires a Remand.

This Court held that the Trial Court failed to compare the claims and the accused equipment and found noninfringement under a misinterpretation of the law. If the Trial Court had an erroneous view of the law as to infringement and that view [*11*] influenced it in reaching its findings of no literal infringement and the absence of equivalents, then this Court's duty is not to make independent, contrary findings, but to remand the case back to the Trial Court for further proceedings to permit the Trial Court to make findings which will resolve the factual disputes. *Pullman-Standard* v. *Swint*, 456 U.S. 273, 291-293 (1982).

. . . .